EDITORIAL

'REVIEW OF THE MONTH' has been omitted in this number in order to make room for the article on the Calaveras dam, which was received too late for insertion in any other department.

CONCRETE has been recognized as a shipbuilding material by the British Board of Trade, preliminary instructions having been issued for the information of builders and owners and for the guidance of the Board's surveyors. These instructions relate mainly to the determination and marking of the load-line. In order that this may be fixed by the Board, plans of the vessel showing the arrangement of the reinforcement, together with calculations of strength. Vessels must be built under the inspection of members of the Board.

RECORDS in both wood and steel shipbuilding have been broken recently at Pacific Coast yards. At the Grant Smith-Porter Ship Company yards on the Willamette river the 3500-ton wooden steamer 'Caponka' was launched in 49 working days after construction was commenced. At the Skinner & Eddy Corporation yard at Seattle the 8800-ton steel steamer 'West Lianga' was launched in 55 working days after the keel was laid. It is expected that the 'West Lianga' will be ready for service within 75 working days from the date of laying the keel.

CONSTRUCTION of the Alaskan railroad by the Federal Government will be delayed this year by the shortage of labor, although the Alaskan Engineering Commission hopes to keep as many as half of last year's force at work this season. The work planned for this year comprises the completion of a 17-mile gap between Seward and Anchorage and construction of the main line to Fairbanks from Mile 216 to some point near Mile 265 or approximately 200 miles from Fairbanks. The total amount expended to the present time is $23,670,000. The original estimate for the total cost of $35,000,000 has been increased to $40,000,000 on account of the increased cost of labor and materials.

MANUFACTURE of clay products is to be restricted as a result of orders issued by the United States Fuel Administration. The restriction is expressed in terms of the average output for the past three years. Thus the manufacturers of common brick, face brick, paving brick, terra cotta, roofing tile, floor and wall tile, and sanitary ware will reduce their output 50%, the manufacturers of hollow tile, drain tile, and sewer pipe, 25%, and the manufacturers of stoneware except that used in the chemical industries, 15%. Wherever possible, equal treatment will be given to all plants but allowance is necessarily made for individual instances where abundance of fuel and absence of congestion make large production in a given district desirable.

READERS of Mr. Cronholm's article in WESTERN ENGINEERING for April on 'Land Leveling With Tractors on the Truckee-Carson Project' will be interested to learn that about 1000 acres of this land has recently been opened to entry, along with some adjoining land that has not been leveled. The construction charge on the level land is fixed at $115 per acre and on the unleveled land $65 per acre. Since the terms are 5% at the time of filing and 5% each year for the first five years, the farmer entering a 40-acre farm-unit of leveled land is theoretically under no greater expense than if entered un-leveled land and prepared two acres immediately and two acres each year thereafter, while he has his entire farm ready for cultivation from the first.

A UNITED engineering society for Australia, membership in which is to be open to engineers of all branches, is likely to be formed as a result of a conference held at Melbourne on February 12 and 13, attended by representatives of the Engineering Association of New South Wales, Sydney University Engineering Society, Electrical Association of Australia, Northern Engineering Institute of New South Wales, Australasian Institute of Mining Engineers, Victorian Society of Engineers, Institute of Local Government Engineers of Australia, Queensland Institute of Engineers, and South Australian Institute of Engineers. The conference recommended the formation of a provisional council composed of representatives of the various societies that is to meet on May 15 and prepare a constitution for submission to the various societies. It was further recommended that the present societies become sections of the united society but that the existing societies should preserve their present individual entity and that Federal control should, in general, be restricted to Federal matters. The proposed society will be a step further than the Engineering Council in this country, and points the way to the greater co-operation among engineers that is bound to come all over the world.

OIL-TRANSPORTATION systems in California are being operated as a unit under the direction of a committee representing the Federal Fuel Administration. Shutting down the General Pipe Line Company's line between Lebec and Los Angeles is the first important result of this move. Conditions as regards both production and consumption have changed materially since this

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line was constructed five years ago. At the present time the production of the southern California oilfields is ample for the requirements of that region, and San Joaquin Valley oil can far better be pumped to the San Francisco Bay region. The line from the Midway field to Lebec and from Lebec to Mojave is still used to pump sufficient fuel-oil for the Santa Fe railroad and thus save the tank-car haul over the Tehachapi pass, but it is even suggested that conditions may arise that will require southern California oil to be pumped through the General pipe-line to the Midway field and thence to San Francisco. Other economies of operation now in force include crowding all the San Joaquin Valley lines to capacity and using the Producers' Transportation Company line to Port Harford as little as possible. In this way the amount of oil that has to be carried in tank-steamers from Port Harford to San Francisco is reduced to a minimum.

OIL production in California during March was 5000 barrels per day less than in February. There was also a decrease of shipments, but this was not sufficient to prevent a reduction of stocks of 288,000 barrels during the month, leaving 31,000,000 barrels on hand on April 1. Some of this oil is below the outlets of reservoirs and tanks, several million barrels is required for storage along pipe-lines and in lines themselves, and stocks are also needed at points of distribution in order to stabilize deliveries. In fact, the 'danger point' for stocks of oil on the Pacific Coast is somewhere between 15,000,000 and 20,000,000 barrels. At the rate of decrease of stocks that has been the rule for the past year or two, this point will be reached about May 1, 1919. The most that can be expected from economies of operation and from the use of other fuel is that they may offset the increased consumption caused by industrial activity directly or indirectly the result of the War. Production must be increased, and the only feasible way to do this is for Congress to pass laws that will permit development of the withdrawn lands. Unless this is done, and done speedily, arbitrary reduction of consumption by denying fuel to the less essential industries cannot be avoided.

NORTHERN ELECTRIC COMPANY'S financial troubles reached a new phase with the signing of a decree of foreclosure by Federal Judge M. T. Dooling. The upset price is $1,750,000 and the sale will probably take place on May 28. About $12,000,000 worth of bonds is outstanding and the cost of the road was approximately the same amount. The system comprises a line from Sacramento to Oroville, Chico, and Hamilton City, with a branch running from Marysville to Colusa, also an unconnected link between Suisun and Vacaville. The company was organized about fifteen years ago by the late Henry A. Butters, of Oakland. The original plans provided for lines tapping both sides of the Sacramento valley and connecting with the company's own steamers at Vallejo. The line along the west side of the Sacramento valley was never built and the only part of the line from Sacramento to Vallejo constructed was the link between Suisun and Vacaville. Neither did the steamship line from Vallejo to San Francisco become a fact. The usual difficulties of a new railroad system in relatively undeveloped territory were aggravated by such unusual events as the San Francisco fire, the panic of 1907, and the loss of several costly bridges and other structures through floods at various times. Matters went from bad to worse, money that was needed for maintenance and betterments had to be used to 'stand off' bondholders and other creditors, until finally a receiver, Mr. John P. Coghlan, was appointed in October 1914. Mr. Coghlan, unlike many receivers, set to work for the interests of the security-holders and patrons of the road, instead of trying to pile up fees for himself and a host of attaches. The road is now in good physical condition and traffic has increased materially, so that there is every reason to believe that a reasonable return can be made on the upset price.

AN earthquake, the most severe that has taken place in California since 1906, occurred in southern California on the afternoon of April 21. It appears to have been caused by movement along the San Jacinto fault. The intensity of the shock corresponded to No. 7 on the Rossi-Ferela scale. The principal damage was in the towns of San Jacinto and Hemet, the total loss in these towns being estimated at $250,000. The direct loss in other parts of southern California was relatively light, and was mainly confined to broken plate-glass and fallen chimneys. It is probable, however, that a number of old buildings will have to be condemned as a result of the shock. Two deaths may be traced indirectly to the earthquake, one from nervous shock and one from a fall as result of a panic in a crowd on a pier. There were a number of minor injuries. The damage at San Jacinto and Hemet was almost entirely confined to brick buildings, frame structures being practically unharmed. Water, gas, power, telegraph, and telephone lines were broken, but this damage was repaired in a few days at relatively small expense. The Hemet dam, the only important structure near the zone of greatest intensity, was not damaged. This is a single-arch masonry structure 122 feet high and containing 30,000 cubic yards of concrete. It was completed in 1895. The Los Angeles aqueduct, the Imperial Valley irrigation system, office-buildings in Los Angeles and other cities, and other structures in southern California were not damaged to any appreciable extent. Concrete-paved roads and streets in and near San Jacinto and Hemet buckled and cracked in many places. This will hardly be used as an argument against using this class of pavement in earthquake districts or even of providing reinforcement unless other considerations render this advisable. Railroads and highways were temporarily blocked by slides in many places. A broken chimney caused the destruction of a farm-house by fire, the only fire reported as a result of the shock. A similar earthquake occurred in the same locality in December 1899, San Jacinto and Hemet being the principal towns affected.

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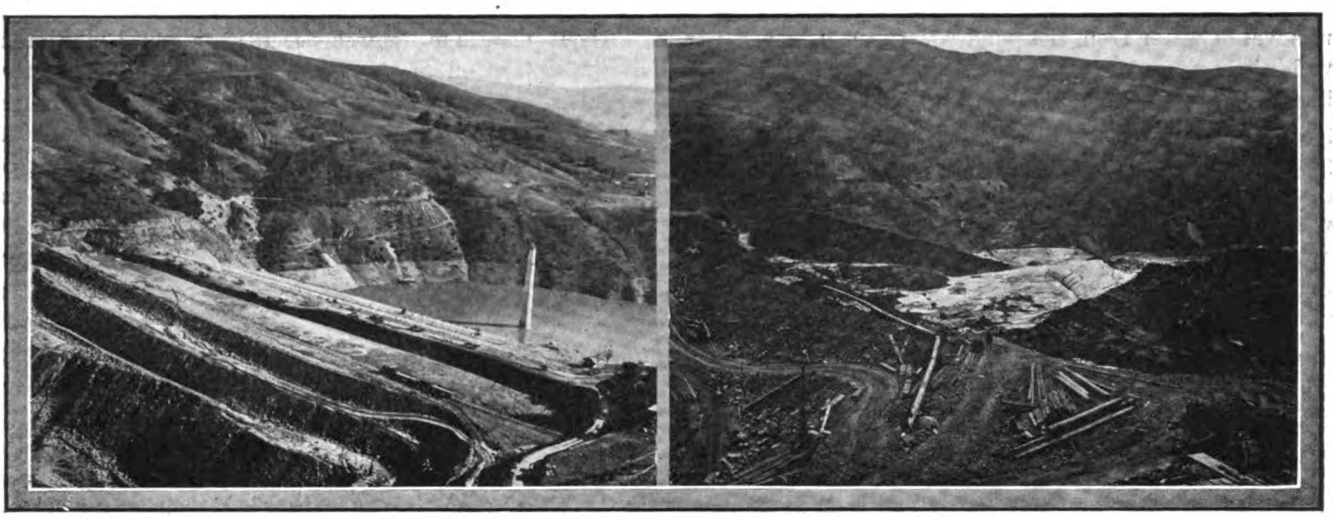

THE DAM BEFORE AND AFTER THE SLIDE

Failure of Part of the Calaveras Dam

The Calaveras dam is being built by the Spring Valley Water Co. on one of the branches of Alameda creek about 45 miles south-east of San Francisco. The direct tributary drainage-area is 100 square miles, which can be increased to 138 miles by the construction of a tunnel 9000 ft. long. The available storage capacity will be 163,000 acre-feet and the safe draft 57,000,000 gal. per day.

The construction of the dam was first proposed in 1873, by T. R. Scowden, an engineer employed by the city of San Francisco. Since that time several of the most prominent engineers and geologists of the country have reported upon the project. Several sites have been proposed, all within half a mile of the one chosen. The original plan was to build a concrete structure about half a mile down-stream from the site finally selected. However, test-pits and tunnels at this point showed that the rock at the east abutment was not suitable. This plan was then abandoned in favor of an earth dam at the present site. Other conditions that led to the selection of an earth structure were its greater safety during earthquakes than a concrete dam, and also its probable lower cost. This latter condition will, of course, not be realized.

The plans finally adopted for the dam called for a height of 250 ft. above bedrock, a crest-length of 1300 ft., a base-width of 1300 ft., and a total volume of 3,100,000 cu. yd. The up-stream side was given a slope of 3 to 1 and the down-stream side 2½ to 1. A spillway with a capacity of 27,000 second-feet and having 20 ft. of freeboard was excavated in the solid rock at the west end of the dam. Bedrock was exposed for 50 ft. on each side of the crest of the dam and a cut-off trench 25 ft. wide was excavated in the rock. This trench was 8 ft. deep for most of the distance but was carried down 70 ft. at the west abutment on account of seamy rock. The outlet works consist of a horseshoe-shaped concrete culvert with net section of 234 sq. ft. This great size was required because the culvert had to carry the first winter's floods with very little head on the inlet. A reinforced concrete gate-tower, 234 ft. high, was constructed at the inlet of the tunnel. The base of the tower was at the side of the inlet of the tunnel.

Construction was commenced in May 1913, the principal work during that season being the construction of

LOOKING WEST ACROSS THE SLIDE

the outlet culvert and of a dike at the up-stream toe of the dam for diverting the flow of the creek. The hydraulic fill was commenced early in 1914. The material obtained from the borrow-pits consisted of gravel, sand, shale, sandstone, and clay. The position of the borrow-pits was such that nearly all the material was pumped. Motor-driven centrifugal pumps were used both to supply water to the hydraulic giants and as mud-pumps. Steel slip-joint pipe, 12 and 14 in. diam., was used. Rocks larger than 4 in. diam. were screened out and broken in a crusher. The method finally adopted for the

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removal of water from the pond was to cut a trench 4 ft. wide through one end of the up-stream toe. A bottomless flume was constructed of 1-in. boards with 4 by 6-in. posts and 2 by 4-in. spreaders. Excess water from the pond was allowed to flow out through the box and run down the slope of the dam, which was riprapped to prevent erosion. To raise the level of the pond, rock and gravel was dropped into the cut sufficient to bring it to the desired height. At the time construction was commenced, F. C. Herrmann was engineer for the company. On his resignation, G. A. Elliott took charge of construction. T. W. Espy has acted as resident engineer throughout the work.

Soon after hydraulic operations were commenced, it was found that the available material had too much clay. To avoid wasting the excess, steam-shovels were set to work in 1915 on a sandstone bluff opposite the down-stream toe of the dam. This material was dumped on both toes. Work continued in this way until June 18, 1917, building up a large part of the outside of the toes with sandstone excavated by steam-shovels and deposited by wagons and cars and sluicing the remainder of the material. On that date a movement of the up-stream toe was observed. The estimated amount of this movement when first observed was 18 in. horizontally and a further movement of 6 in. occurred in the next 12 hours. At this time both toes were approximately at elevation 740, or 180 ft. above bedrock and 150 ft. above the stream-bed.

Sluicing was stopped immediately after the first movement was observed. The movement of the up-stream toe continued for three days at a decreasing rate and then practically ceased. Since that time sluicing has been done at only two periods, between July 7 and 19, 1917, and between February 12 and March 4, 1918, being stopped both times because horizontal movement of the up-stream toe was again observed. The total horizontal movement between June 18, 1917, and the morning of March 24, 1918, the day of the failure, was about 4 ft. At this time the elevation of both toes was about 760, and of the central hydraulic fill about 752. The elevation of the water in the reservoir was about 653. Tests had been made from time to time to determine how the material in the hydraulic fill was solidifying. Up to February 12, 1917, the method used was to ascertain the depth to which a man could force a 1½-in. pipe down into the material from a boat. This depth ranged from 75 to 90 ft. After February 12 this method was abandoned in favor of lowering a 6-in. cast-iron ball into the core-material and observing the depth to which it would go. On this date the ball could be lowered to a depth of 45 ft. This distance gradually decreased until on January 21, 1918, the ball would penetrate to a depth of only 5 ft. Up to the time of the failure, 1,543,353 cu. yd. of sluiced material and 1,252,025 cu. yd. of material excavated by steam-shovel was placed in the dam, making 2,795,378 cu. yd. in all. The steam-shovel material was mainly sandstone. Just what were the proportions of the various constituents in the sluiced material cannot be determined, since the character of the material varied, but it is probable that more than 50% was clay.

About 7:30 a.m., March 24, 1918, a rapid movement of the up-stream toe commenced, and in less than five minutes this part of the dam slid into the reservoir, releasing the clay and mud in the centre of the dam. At the west end the movement of the toe was small but on the east end it was more rapid so that the whole toe swung around until it was at an angle of about 30° with its original position. The material in the central part of the dam flowed out into the reservoir through the opening made at the eastern end of the dam. In spite of the indications shown by the tests already mentioned, this material proved to be almost as fluid as when originally placed in the dam.

The movement of the toe of the dam carried with it the concrete gate-tower, which fell forward into the reservoir. The mud and other debris choked the outlet tunnel almost immediately, so that little water escaped down the creek. The tunnel itself was not broken or otherwise damaged. The total amount of material that moved during the slide has been found by rough measurements to be 790,000 cu. yd., or about 28% of the amount that had been placed in the dam up to the time of the slide. Of the material that moved, the rock and gravel of the up-stream toe extends out into the reservoir for a considerable distance at the western end and is for the most part above the water-surface. The clay and mud of the central core flowed into the reservoir at the eastern end of the dam. The down-stream toe is practically undisturbed although there have been a few cracks and a little settlement on the upper side resulting from the release of pressure from the central pool. The gate-tower fell into the reservoir at an angle of about 45° with the axis of the dam. Since the accident several drill-holes have been sunk into the material of the up-stream toe. It has been found that the steam-shovel material extends for about 10 ft. below the surface, the rest of the material being the hydraulic fill well dried and solidified, unlike the material nearer the centre of the dam, which flowed through the opening in the up-stream toe into the reservoir at the time of the accident.

In order to release the water from the reservoir a new outlet-tunnel is being driven through the rock at the side of the dam, both ways from a shaft. The shaft, which has a 5 by 7 ft. cross-section and is 100 ft. deep, was completed in 20 working-days. The total length of the tunnel will be 1350 ft. It will be horseshoe-shaped, 8 by 8 ft. On April 26 the water-surface in the reservoir stood at elevation 656. Records of rainfall and runoff on the Calaveras watershed for the past 20 years show that with an average runoff the water-level in the reservoir should rise 8 ft. after May 1. For the maximum runoff recorded the rise would be 27 ft. The down-stream toe is therefore strong enough to take care of all the water that can possibly flow into the reservoir before the next rainy season, by which time the new outlet will have been completed.

Plans for the completion of the structure are being prepared by G. A. Elliott, engineer for the Spring Valley Water Co., Allen Hazen and William H. Burr acting as consulting engineers.

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DISCUSSION

Increasing the Production of Oil in California

The Editor:

Sir—It is surprising to note that the impression is being, and has been, conveyed throughout California that all of the possible oilfields of this State are known and are at the present time either fully or partly developed. It is even more regrettable that the notion should exist that all future production must come from present known fields or extensions of them.

Being aware that it has been the American pioneer spirit that has found and proved new fields in the past, and being slightly acquainted with some of the geological conditions in untested areas throughout this State, I venture to express an optimistic view.

When O. D. Barton first went into the Lost Hills to prospect for oil he operated with a small rig capable of drilling only to a shallow depth. This he used in the face of adverse comment and the knowledge that the best previous technical calculations had determined a depth beyond reach of his drill (U. S. G. S. Bull. No. 406 p. 207) for the only oil-sand then considered as having a prospective value. There was genuine surprise in California when his well, at 527 ft., proved a good producer. The facts of the discovery were that he had used his own judgment regarding the interpretation of the oil indications in the immediate vicinity, he had faced all the hardships connected with getting such a venture under way, and he was rewarded by discovering favorable conditions for the occurrence of oil that had not been surmised before in that locality. Whether or not he previously realized all the phases of his venture is not known to me; nevertheless, the desired production was obtained, and the example here set may illustrate in a way the mistake made by discouraging wild-cat prospects too hastily.

Oil was found in the Lost Hills as an accumulation in overlying porous beds near the line of an unconformity (Bulletin 69, California State Mining Bureau). This relation exists in other fields south of the Lost Hills as far as Sunset and possibly is limited only by the extent of the San Joaquin valley and certain formations that exist through at least the south half of that depression. This possibility has been recognized, but it has not, as yet, been thoroughly tested. It, therefore, forms the starting point for some important future discoveries throughout a large area around the rim of the valley and in other parts of California. Until it has been investigated thoroughly both from a geologic standpoint and with the drill there is much room for new and important discoveries.

The development of the Santa Maria and Lompoc oilfields has proved that oil can accumulate in the cracked flints and shales of the Monterey shale series. Just how productive some of the best wells in this shale have been is indicated by the fact that one well that came in at 8000 bbl. per day in 1904 was making at the rate of over 200 bbl. per day in 1915; moreover, another well developed in the same series of beds came in at 1675 bbl. in 1906 and is still producing freely. The shale and its associated beds, which give rise to this oil and form a reservoir for its accumulation, are widespread and frequently thick, throughout large portions of this State from Point Arena in Mendocino county to near the Mexican border. Wherever found, oil indications are manifest somewhere in the immediate neighborhood. While some of these shale areas have been tested in a desultory manner they have by no means been thoroughly investigated or prospected, largely because of the difficulty in drilling the hard flint beds associated with them, partly because of poor financing, and partly because of past over-production of cheap oil. Until these shale areas have been investigated and tested, there is still room for other important oil discoveries as at Santa Maria and at Lompoc.

Deep drilling in the main Santa Maria oilfields has developed the fact that beneath the productive cracked flint and shale beds lies some true sand (the Vaqueros sand) that is productive. This oil-sand has considerable extent throughout portions of Santa Barbara county and adjacent areas. It has not, as yet, been systematically investigated. At the outcrops the sand shows unmistakable indications of oil at many places.

In northern California is a wide extent of beds deposited during Cretaceous time. In places these beds have developed seepages of a paraffine oil. The geological horizon of these seepages is somewhat similar to that of certain oil-horizons in Wyoming. Work of a preliminary and cursory character has been attempted, as yet without success. To my knowledge, however, the entire Cretaceous region of northern California has not been studied thoroughly. Until it has been so studied and tested no one has the right to denounce the area. From what has been observed in a preliminary way it appears that some of these Cretaceous districts invite further investigation.

There has been much wild-catting throughout the State since the first attempts to produce oil. Where success has followed large fields have been developed; where unsuccessful the territory has generally been condemned. Before rejecting any previously tested area it has been found good practice to get a history of the developments and to ascertain, if possible, any reason other than the lack of oil for abandonment. It is possible that several prospective fields have been given an unwarranted 'black eye.' For example, I had occasion to investigate one prospective field where there had been some previous drilling. I found that the field had been condemned by

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wells drilled at various times, none of which produce commercial oil. Closer observation disclosed that every well had been drilled near the outcrops of the oil-sand and that the only logical place for testing the district was an anticline involving the oil-sand and situated but a short distance away. This field has so far been entirely neglected.

Again, before denouncing the future possibilities of Californian fields by noting the decline in production in 1916, the present draft on the stock of oil and the small amount of new territory brought in during the last two years, it is well to inquire into the reasons for the present conditions other than the withdrawal of Government lands and the setting aside of naval reserves in the Buena Vista and Elk hills. These facts have a most important relation to the failure to bring in much new territory during that period.

With the tremendous over-production of petroleum in California from 1910 to 1916 and in the mid-continental oilfields in 1914-1915, stocks of crude oil mounted continuously until there was 59,777,789 bbl. in storage in California in May 1915. For this over-production wild-cat wells were largely responsible. With a continued surplus production, prices ebbed and the operators found themselves on the edge of ruin. The situation was alarming, and to prevent disaster they adopted several remedies. All new drilling was discouraged, many producing wells were shut-down, new markets were sought, and all wild-catting discouraged. The results have been as desired. Over-production has been stopped, prices have been increased, stocks have been decreased, and the minimum of new fields is being brought in, resulting withal to the prosperity of the producers, just as was directly planned by them before our entrance into the War.

Now, however, the War is making new demands and the reverse of these protective measures is desired. More oil is needed, a surplus in stocks is necessary, and it becomes a duty to increase production. This is an adjustment requiring time. Fortunately the operators' seven years of past difficulties have developed the best that there is in them and confidence is felt that they will meet the requirements. Just how they are commencing is indicated in a measure by the increase in production in 1917, over 1916, from 91,976,019 to 97,781,574 bbl., by the more careful conservation of oil, and by the bringing in of the one new field at Montebello.

Since this article has to do with wild-catting, the new development of the Montebello oilfield is one of the best object-lessons in favor of that particular and necessary branch of the industry as a method of making up the necessary shortage. With stocks previously being depleted at the rate of 30,091 bbl. per day during 1917, this new field alone has produced enough to offset that draught at the rate of 10,000 bbl. per day in January and 12,000 bbl. per day in February 1918, and gives reason for a more optimistic belief in future possibilities. When it is further remembered that all past production from all wells has been made possible only through wild-catting, the vital importance of this enterprise can be the better appreciated. It illustrates the high value of courageous initiative.

It is fortunate that large areas of prospective oil-lands are owned by deed, patent, or grant, and are available for acquisition and testing. The circumstance is also fortunate that all of the Government holdings have not been classified as prospective mineral lands and withdrawn from entry. Idleness on the part of all operators is, therefore, not necessary, for want of prospective territory during the period that the legal and legislative snarls relating to naval reserves, lands withdrawn from entry, and Government receiverships are being untangled and re-snarled again in Washington. In spite of all these difficulties there is much to be done in wild-catting new territory.

In this necessary branch of the industry, if prices can be maintained and the production absorbed, there is certainly much to be done in California in stimulating the operators. Although somewhat out of practice because of the inaction primarily due to the long continued low prices, there is surely enough of the pioneer spirit left among our operators to attack the problems at hand, using at the same time all of the available knowledge and experience gained through forced economies during the last few years. Montebello is a beginning, but other similar fields must be found. If but one in four or five new wild-cat areas prove productive, the record will not be poor, particularly when it is remembered that the high gas-pressure with the accompanying flush production of a new field acts as an offset to the failure in other areas tested. An honest failure in this branch should always call for praise as a worthy and patriotic effort and not for ridicule as is too often the case, for it takes grit to face the necessary risks, and in carrying on such enterprises the operator is doing a war-time service. If successful, his pecuniary reward more than offsets his troubles.

There is every reason to place the utmost confidence in the type of man that has so far survived the hardships of the Californian oil industry. Through his past hardships he has developed into an individual who can meet any oilfield difficulty and intelligently, energetically, and successfully solve it. When all operators strive for an object something usually happens in the oilfields. The small operator has proved himself a particularly active and successful worker in prospective territory in the past. Wild-catting is a branch of the industry where he has really done brilliant work. With the larger companies now giving more attention to this vital necessity, the small operator also becoming interested, and in view of the large amount of prospective territory to be tested, there is abundant reason to believe that in addition to the new Montebello field other new fields will be brought in to increase the desired oil-supply and incidentally to demonstrate the true latent oil possibilities of this State as the clearest possible refutation of the pessimistic idea that all of the oilfields of California have been discovered.

WALTER STALDER.

San Francisco, April 2.

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Multiple-Arch Dam Withstands Overtopping During Construction

By H. L. TILLEY*

The Lake Hodges dam is in San Diego county, California, on the San Dieguito river about twelve miles above Del Mar. It is an Eastwood multiple-arch dam, and is being constructed by Bent Bros., of Los Angeles, for the San Dieguito Mutual Water Co., whose president is Ed Fletcher of San Diego. The crest of the dam is 130 ft. above the bed of the stream. At the spillway-level, the dam is 558 ft. long. There are 24 arches and 25 buttresses. The buttresses are spaced 24 ft. centre to centre, and are 48 in. thick at the base and 17 in. thick at the top. The dam impounds 37,500 acre-feet, or 12,218,922,500 gal. of water. The maximum depth of the reservoir is 110 ft., and it extends for seven miles up the San Dieguito river.

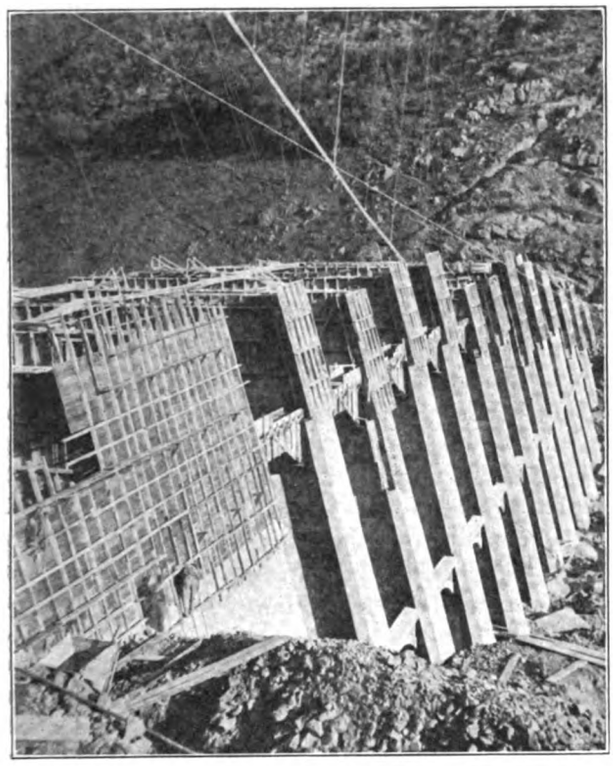

FIG. 1. DOWN-STREAM SIDE OF DAM

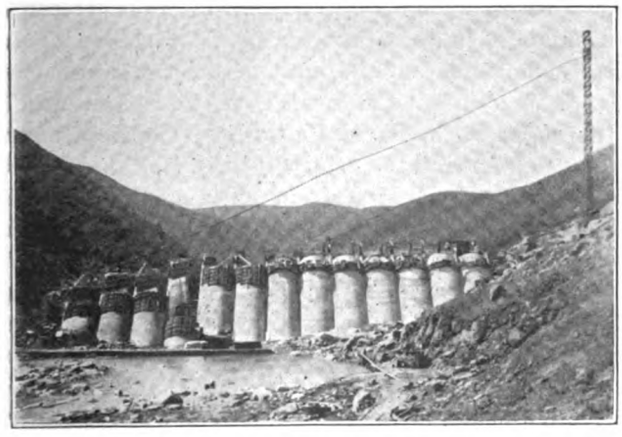

FIG. 2. UP-STREAM SIDE OF DAM. THE LOW ARCH IS NO. 17, THE NUMBERING DECREASING TOWARD THE RIGHT

*Construction superintendent, 3753 Lincoln Ave., Oakland, California.

I have heard reputable engineers claim that, if one arch of a multiple-arch dam should fail, the entire structure would go out. The following facts seem to show that the multiple-arch type has not been given sufficient credit for strength in this particular. On March 7, 1918, the Lake Hodges dam was about 60% completed, the buttresses being finished to elevation 267, or about 67 ft. above the bed of the stream. (See Fig. 1.) Arches No. 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, and 20 were completed to an elevation of about 50 ft. above the bed of the stream. Arch No. 17 was only 30 ft. above the bed of the stream. (See Fig. 2.)

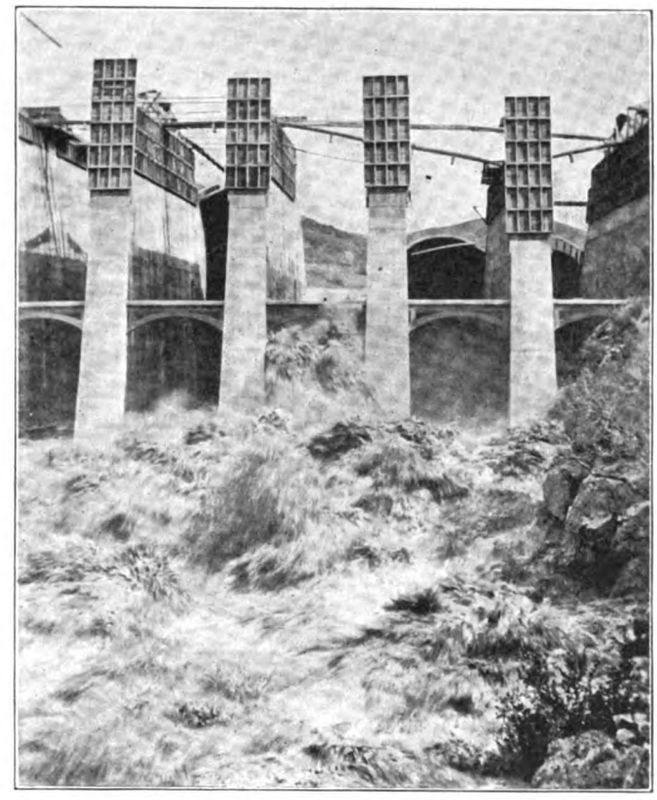

FIG. 3. WATER POURING THROUGH OPENING IN ARCH NO. 17

A rain-storm started in southern California on March 7. On March 9, the four 24-in. sluice-gates near the bed of the stream in arch No. 16 were unable to discharge the water as fast as it entered the reservoir, and

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the water-level began to rise. Inside and outside forms were then ready for pouring concrete to a height of 8 ft. more on all the arches. By 9 a.m., March 10, these empty forms on the low arch (No. 17) impounded the water to a depth of 38 ft. in the reservoir and 8 ft. above the concrete in the low arch. About 9 o'clock the forms on this arch suddenly gave way and the water began pouring over the concrete in a stream 8 ft. deep and 20 ft. 6 in. wide. The water-level continued to rise until about 12:30 p.m., when it reached its maximum height of 46 ft. above the stream-bed and 16 ft. above the concrete where the forms failed. At this maximum height, a stream of water approximately 16 ft. deep and 20 ft. 6 in. wide, or about 7000 second-feet, was going over the low arch. The water filled the space between buttresses No. 17 and 18 to a depth of 28 ft. above the stream-bed, or about 6 ft. below the top of the strut. (See Fig. 3.) The flow of water continued over the arch at this rate until about 4 p.m., when it began to drop slightly. At 7 a.m., March 11, the water was still 14 ft. deep over the arch. On March 14 water ceased flowing over the arch and construction was resumed. The ½-in. reinforcing-steel in the arch over which the water flowed was bent sharply at the concrete, and the top of the concrete was rounded and polished, but not otherwise damaged. The concrete in 8 ft. of the top part of arch No. 17 was 10 days at the time of the flood, and the concrete in arches No. 15, 16, 18, 19, and 20, adjoining No. 17, was only a few hours old.

At the time of maximum height of flood I walked through the buttresses from one side of the dam to the other, at a distance of 30 ft. back from the arches and 34 ft. above the stream-bed. Only at buttresses No. 15 and 16 was the vibration more than barely perceptible. These two points were on each side of the arch containing the sluice-gates. The buttress adjoining the south side of the opening through which the flood was passing was vibrating only slightly.

The water going over the arch and between buttresses No. 17 and 18 carried several timbers and a number of stumps and logs up to 12 in. diam. and 24 ft. long, but did not even break the concrete in the wings of the buttresses, although many of these timbers struck end-on against the projecting concrete while traveling at a speed of 30 ft. per second.

Another fact I noticed that speaks for the excellence of the concrete was that only in one place was there any evidence of leakage on the back of the arches at the junction of the arch with the buttresses. At this point the concrete was only slightly damp. This water-tight condition of the concrete is particularly remarkable because the face of the arches for a distance of several feet above the stream-bed had not been coated with the cement-gun.

Water from Lake Hodges reservoir will be delivered to a 19,000-acre tract on a coast mesa between Oceanside and Del Mar, about 12 miles from the dam. The conduit system includes 18,622 lin. ft. of open concrete-lined ditch from the main dam to a small secondary reservoir. From this reservoir, the San Dieguito, a 42-in. concrete pipe-line delivers the water to the distribution system. Bent Bros. also have the contract for the conduit, the San Dieguito dam, and the concrete-pipe distribution system.

There are some interesting features connected with the construction of the conduit. For a distance of 11,700 ft. from the intake the conduit follows a steep rugged side-hill and crosses many rough steep-walled gulches. Construction of a road for hauling sand and gravel along the line of the conduit was impractical and there was no room along the bank of the excavation to place a concrete-mixer. The contractors have therefore decided to place their mixer at stations 400 ft. apart and 200 to 300 ft. below the conduit along a road near the river-bed. Here sand is almost within wheelbarrow distance. Crushed rock can be obtained by a down-grade haul from the crusher. An ordinary hoist will elevate the concrete 'buggies' to the conduit and they will then be wheeled by man-power in either direction to the forms.

The gulches are crossed either by ordinary steel flumes on reinforced concrete trestles or by concrete pressure-pipe on similar trestles. Three methods of constructing these trestles were considered. First, to pour the concrete in place for each trestle. Second, to mold the structures in units at a central yard, haul the units by teams to the nearest accessible point, hoist them up the hillside to the site, and erect them with some form of hand-derrick. Third, to mold the trestle-units on the ground where they are to be erected, the concrete coming from the regular conduit-lining mixer and being delivered to the unit-forms by the same method as for the concrete lining. Units for each structure would then be poured as conduit-lining progresses and reaches each site. When the units were sufficiently aged, they would be erected with a hand-derrick, which would move each unit from the molds to its position in the trestle. This third method was adopted.

The San Dieguito Mutual Water Co. is controlled by the Santa Fe Railway Co. and by W. G. Henshaw, of Oakland. It was organized by Ed Fletcher, of San Diego, who is one of the most active water conservationists in southern California. W. E. Hodges and E. O. Faulkner of the Santa Fe Railway Co. were instrumental in financing the project. Lake Hodges is named for the former. E. W. Case is chief engineer for San Dieguito Mutual Water Co. John S. Eastwood, of San Francisco, designed the Lake Hodges dam. Mr. Fletcher is also interested in other water-storage projects, including the Volcan water system, owned and controlled by Mr. Henshaw. When completed, this will be the largest irrigation project on the coast of southern California. James A. Murray, Mr. Henshaw, and Mr. Fletcher also control the Cuyamaca water system on the San Diego river, and have just completed an Eastwood multiple-arch dam, 116 ft. high and 900 ft. long, known as the Murray dam, increasing the storage capacity on this system.

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Economics of Steel Bridges

In a paper presented recently by J. A. L. Waddell at a meeting of the American Society of Civil Engineers, and printed in the 'Proceedings' of the Society, the results of an investigation of the economics of steel-arch bridges are given, including the following conclusions:

Economic Ratios of Depth to Span-Length. For three-hinged arches having the grade-line approximately tangent to the top-chord of the arch at the crown, the average economic ratios of rise to span-length are as follows:

Solid-rib structures	0.20
Braced-rib structures	0.225
Spandrel-braced structures (with hinge above)	0.25

These values may be either increased or decreased by 0.025 without making any material difference in the economics.

For three-hinged half-through, arch bridges, the average economic ratios of rise to span-length are as follows:

Solid-rib structures	0.225
Braced-rib structures	0.3

For three-hinged, high-deck, arch bridges, they are as follows:

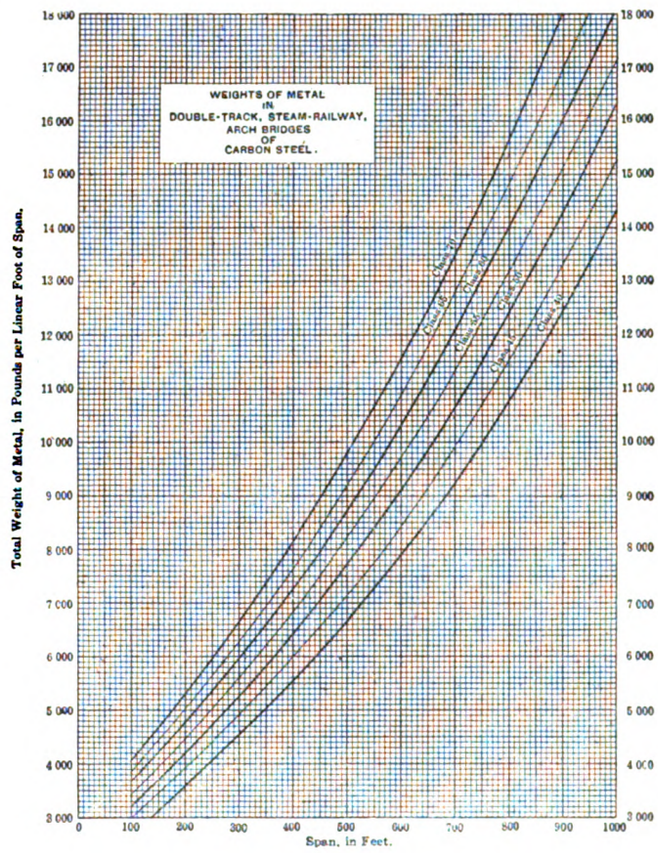
Solid-rib structures	0.25 to 0.28
Braced-rib structures	0.33 to 0.38

For two-hinged arches and combined two-hinged and three-hinged arches, the economic ratios of rise to span will be practically the same as for three-hinged structures. For the hingeless arch, a somewhat greater ratio of rise to span than that for the three-hinged arch is economical. The single test of this made for the 500-ft. span indicates that the best ratio is about 0.28 with low-grade deck, 0.33 for half-through arches, and 0.38 with high-grade deck.

Economic Depth of Ribs. In respect to solid-rib arches, the question of economic depth of rib does not arise; for the depth should always be made as great as a proper consideration of the section for resisting compression will permit. For braced-rib three-hinged arches the economic rib-depth is about 7.5% of the span length, but a considerable variation from that proportion may be made without materially increasing the weight of the metal. The economic average depths for hingeless and two-hinged arches will be about the same as the economic depths for three-hinged arches. The best form for a two-hinged arch is the crescent shape, but there is no great economy in this over the rib with uniform depth. The best shape for the hingeless arch is secured by making the depth at the crown about one-half of that at the springing points.

Economic Position of the Crown-Hinge, in Three-Hinged Spandrel-Braced Arches. For all cases the most economic position for the crown-hinge in a spandrel-braced arch is in the top-chord. In braced-rib and solid-rib arches, however, the hinge should be placed at mid-depth, so as to distribute properly the thrust over the two chords.

Weights of Metal for Solid-Rib, Braced-Rib, and Spandrel-Braced Arches. Comparing the economics of solid-rib, braced-rib, and spandrel-braced arches, the first mentioned is always considerably heavier than either of the others. Under normal conditions of the metal market it is also more expensive. The spandrel-braced arch requires for long spans a little more metal than the braced-rib arch; but, in case of cantilevering, this would generally be offset by the extra quantity of



erection-metal needed for the braced-rib structure. In short spans, the spandrel-braced arch is a trifle the lighter.

Weights of Metal for Hingeless, Two-Hinged, and Three-Hinged Arches. Comparing three-hinged, two-hinged, and hingeless arches, it was found that the three-hinged is a little heavier than the two-hinged, but nearly always lighter than the hingeless. The variations in weight among the three types, however, are never great.

Arches Three-Hinged for Dead Load and Two-Hinged for Live Load. The combination of three hinges for

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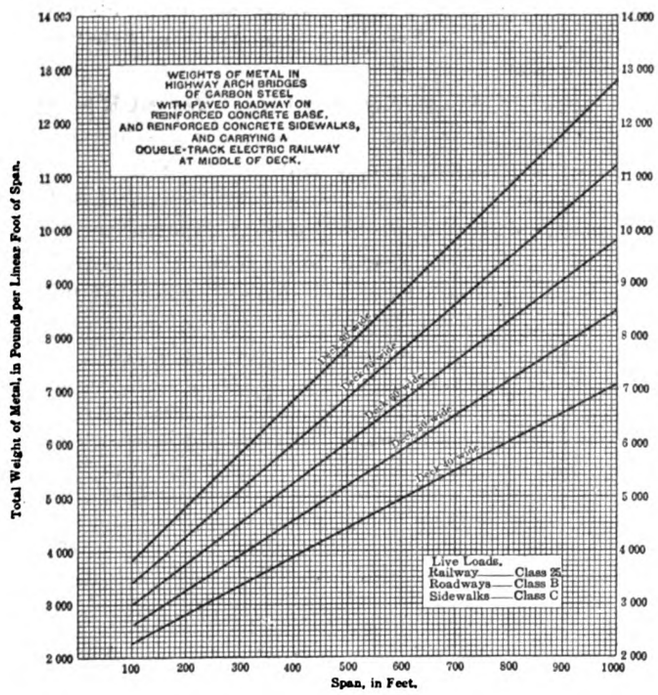
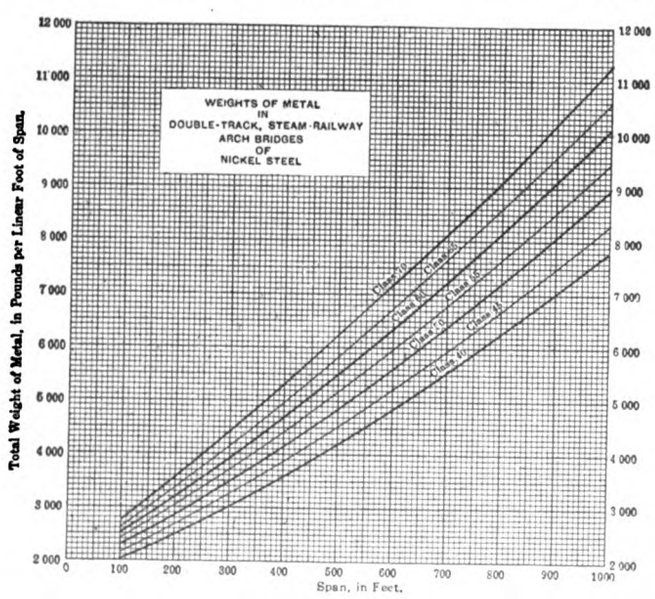
dead load and two hinges for live load produces little saving over the three-hinged type; but it adds materially to the rigidity. In my opinion, the combined type is preferable to the others.

Cantilever Arches. When an arch is flanked by other spans than arches, it is generally economical to canti-



lever the ends of the arch and to shorten the length of the simple spans. The best proportions for lengths of cantilever arm and suspended span to total length of flanking span are, respectively, 0.4 and 0.6.

Comparative Weights of Arch and Truss Bridges. The ratios of weights of arches to the weights of the tive economy in highway structures than in railway



corresponding simple spans for both railway and highway bridges have been determined and plotted. As was anticipated, the arch usually effects a greater relastructures of the same length. The longer the span the greater is the proportionate saving of metal.

In dealing with the comparative economics of arches and simple trusses, it must not be forgotten that there are other factors than mere weight of metal involved; for the pound price of the manufactured material is generally somewhat greater for the former, and sometimes the cost of erection also is larger. Again, the comparison of the cost of arch superstructures and truss superstructures alone is not of much importance; for an economic investigation, to be of any value, must include both substructure and superstructure; and the costs of the former are likely to differ considerably in arch designs and simple-truss designs for any crossing.

PROPOSED STANDARDIZATION OF RAILROAD LOCOMOTIVES

In an address delivered at the sixth annual meeting of the United States Chamber of Commerce, Alba B. Johnson, president of the Baldwin Locomotive Works, told of the progress made in the direction of standardization of locomotives since the Government took over the railroads. The work of preparing standard specifications was entrusted to a committee composed of eleven railroad officials and three locomotive builders. Twelve standard sizes have been recommended as follows:

Two sizes of the Mikado type, 2-8-2, with axle-loads of 55,000 and 60,000 lb., respectively, the total weight to be 290,000 and 325,000 pounds.

Two sizes of the Mountain type, 4-8-2, axle-loads 55,000 and 60,000 lb., total weight 320,000 and 350,000 lb., respectively.

Two sizes of the Pacific type, 4-6-2, axle-loads 55,000 and 60,000 lb., total weight 270,000 and 300,000 lb., respectively.

Two sizes of the Santa Fe type, 2-10-2, axle-loads 55,000 and 60,000 lb., total weight 360,000 and 390,000 lb., respectively.

A six-wheeled locomotive, 0-6-0, with tender, axle-load 55,000 lb., total weight 165,000 pounds.

An eight-wheeled switching locomotive, 0-8-0, with tender, axle-load 55,000 lb., total weight 165,000 pounds.

A six-coupled Mallet locomotive with trucks, 2-6-6-2, axle-load 60,000 lb., total weight 440,000 pounds.

An eight-coupled Mallet locomotive with trucks, 2-8-8-2, axle-load 60,000 lb., total weight 540,000 pounds.

The tenders have been standardized, with tanks of a capacity of 8000, 10,000, and 12,000 gal., respectively.

Unsaturated hydrocarbons may be present in gasoline to the extent of at least 12% without interfering with its value as a motor-fuel, and it is probable that a considerably larger proportion is not objectionable. Methods for determining the proportion of these unsaturated hydrocarbons are discussed in Technical Paper No. 181 of the U. S. Bureau of Mines, by E. W. Dean and H. H. Hill.

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Report of the Kern County Highway Commission

In 1913 the citizens of Kern county voted bonds for $2,500,000 for the construction of a county highway system. A County Highway Commission was appointed, composed of A. J. Woody, J. L. Evans, and C. E. Getchell. Later Mr. Getchell resigned and W. W. Colm was appointed to succeed him. P. H. Everett was appointed chief engineer, and when he resigned in 1915, H. C. Foster succeeded him and completed the work. Actual construction was commenced in 1914. In 1917 the funds available were exhausted although several highways included in the original plan had not been constructed. Since the county is near the limit of its bonding capacity, no additional bond issue was attempted, and work on the system was stopped. The County Highway Commission has recently rendered its final report, from which most of the data contained in this article have been taken.

The bonds were sold at a premium so that the total amount obtained was $2,635,129. Revenue from other sources amounted to $1421, bills receivable to $21,739.25, making a total of $2,658,289.25. On the various highways, $2,499,835.17 was expended and the accounts distributed as shown below. Undistributed expenditures are as follows:

Preliminary expense, including cost of bond election	$ 7,614.71
Quarry investment	114,384.65
Small tools, storehouse supplies, office fixtures, engineering equipment, and automobiles	11,843.35
Bills payable	24,735.89

Making a total of $2,658,413.77, and leaving a deficit of $124.52. Against this deficit may be placed the quarry, quarry equipment, and other equipment, which have not yet been sold. When this equipment has been sold and the depreciation distributed, the cost of the roads as given below will be increased 4 to 5%. The work required 168,536.6 bbl. of cement, costing $363,806.99, or an average of $2.15 per bbl. The total amount of rock used was 286,128.11 tons, costing $318,477.98, or $1.11 per ton. Since most of this rock was obtained from the quarry owned and operated by the Highway Commission, the total cost of rock should be increased by an amount equal to the depreciation in value of the quarry and equipment. This would probably make the total cost of the rock about $1.40 per ton.

Work was done on 277.56 miles of highway, of which 110.38 miles was paved with concrete with a thin asphaltic surface, 20.4 miles was paved with oil-macadam, 6 in. thick and 16 ft. wide, 35.69 miles was surfaced with broken stone 16 ft. wide, and 111.09 miles was simply graded. Of the concrete pavement, 8.32 miles was 4½ in. thick and 12 ft. wide, 69.81 miles was 4½ in. thick and 15 ft. wide, 7.25 miles was 4½ in. thick and 16 ft. wide, and 25 miles was 5 in. thick and 16 ft. wide.

The following table shows the mileage and expenditures by divisions:

	Total mileage	Total expenditures
Div. 1—Delano-Richgrove	8.57	$ 51,891.54
Div. 2—Wasco-McFarland	4.25	42,483.19
Div. 3—Wasco-Lost Hills	21.62	290,981.81
Div. 4—Rio Bravo-Shafter	9.56	59,491.71
Div. 5—Bakersfield-McKittrick	31.05	369,397.30
Div. 6—Maricopa-Taft-Fellows	14.00	184,158.60
Div. 7—Bakersfield-Taft	36.35	451,937.64
Div. 8—Old River-San Emidio	15.80	92,676.65
Div. 9-A—Bakersfield-Glennville	31.63	124,443.11
Div. 9-B—Bakersfield-Oil Center	3.03	42,891.61
Div. 10—Bakersfield-Mojave	80.59	645,946.13
Div. 11—Caliente-Kernville	37.20	81,800.81
Div. 12—Randsburg district	8.51	60,950.42
Total	302.16	$2,499,835.17

Of this system, divisions No. 1, 2, 3, and 4 and all of division 5 except a short section near the town of McKittrick were in level or gently rolling country. The highways for the most part followed existing roads, usually along section-lines. Under these conditions the cost of grading was low, ranging from $300 to $910 per mile. As there is almost no local drainage, the cost of bridges and culverts was also low except where the highways crossed branches of either Kern river or Poso creek, both of which streams rise in the Sierra Nevada mountains. Where, as in most cases, the bridge-work required was confined to irrigating ditches and small washes, the cost was about $100 per mile. The cost of the broken stone surface 16 ft. wide ranged between $0.055 and 0.059 per square foot. Concrete pavement 4½ in. thick cost from $0.11 to $0.158 per square foot, the difference in price being partly explained by the fact that the lower figure was on a road through a settled country near a railroad and where water could be obtained at several points, while the higher figure was in a desert country 10 to 20 miles from a railroad and with only a few sources of water available. Concrete pavement 5 in. thick cost from $0.129 to $0.151 per square foot. The overhead cost for engineering ranged from 2.6% to 6.5% while the administration overhead ranged from 1.5% to 2%. Because of the alignment of the highways, the cost of preliminary surveys must have been low. A stretch of 1.4 miles near McKittrick was graded at a cost of $3477.83 for grading, $880.70 for bridges and culverts, $769.90 for engineering, and $104.77 for general expense, making a total of $5233.20. The overhead was 16.9% for engineering and 2.2% for administration. This road was in hilly country.

Division No. 6 was in rolling desert country through the oilfields. Cost of grading was about $1000 per mile and of bridges and culverts about the same. The concrete pavement, which was 4½ in. thick and 15 ft. wide, cost $0.13 per square foot. The overhead costs were 6% for engineering and 1.9% for administration. The alignment followed old roads for only part of the distance.

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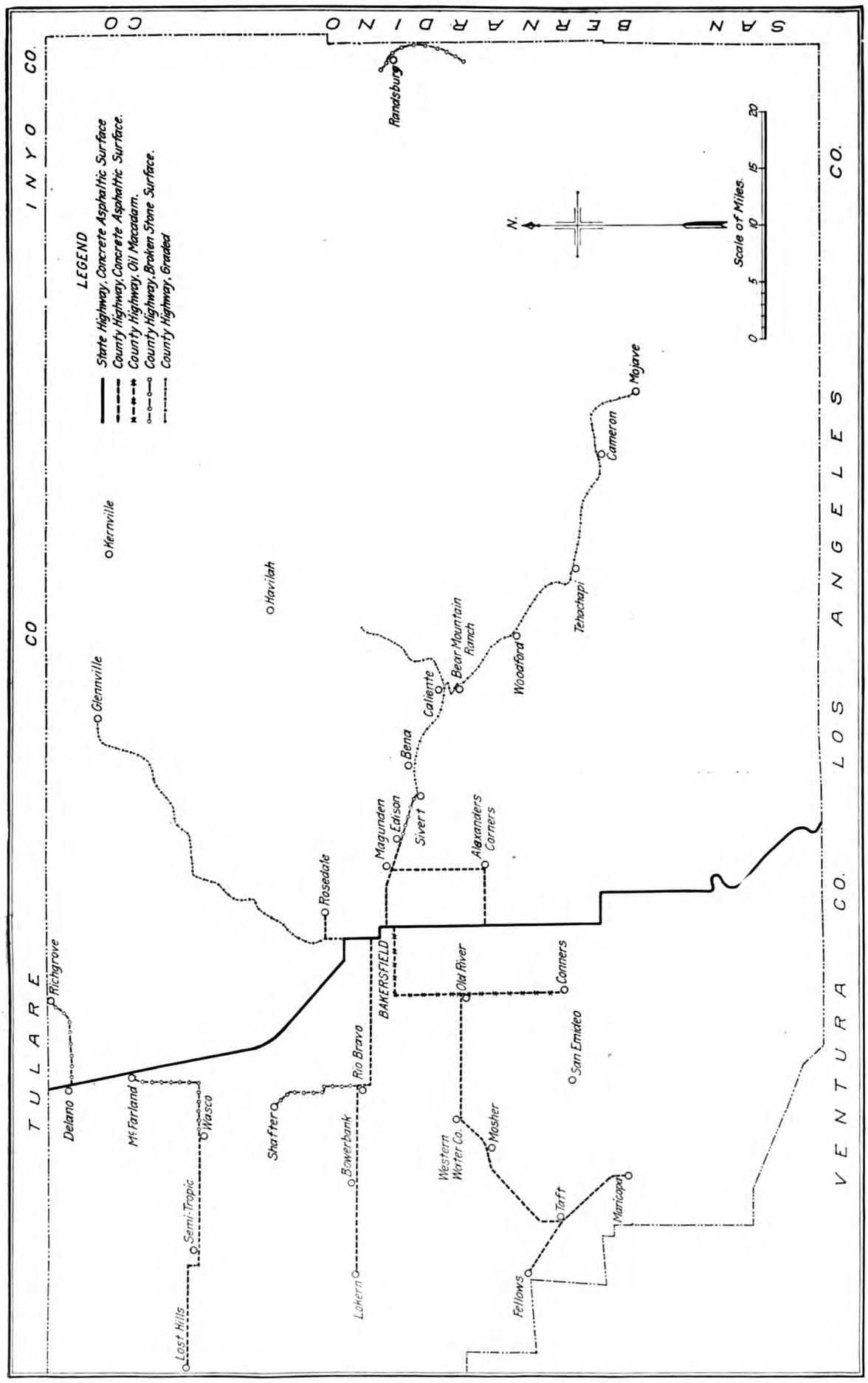

KERN COUNTY HIGHWAY SYSTEM

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Section 1 of division 7 was in a level country with only a few crossings of irrigating ditches. Grading cost $250 per mile and culverts $775 per mile. Oil-macadam pavement 6 in. thick by 16 ft. wide cost $0.09 per square foot. Engineering overhead was 2.8% and administration 1.5%. The alignment following existing roads along section-lines. Section 2 of this division was in similar country but was paved with concrete. Grading cost $250 per mile and bridges about the same. Concrete pavement 4½ in. thick and 15 ft. wide cost $0.133 per square foot. Engineering overhead was 3.5% and administration 1.8%. Sections 3 and 4 of this highway were in rolling and hilly desert country. Grading cost $1200 per mile and culverts $800 per mile. Concrete pavement 4½ in. thick and 15 ft. wide cost $0.14 per square foot. Engineering overhead was 3.8% and administration 1.9%. The alignment followed old roads for a large part of the distance.

Section 1 of division 8 was the only part of this highway that was completed. This was in level country. Grading cost $500 per mile and culverts $200 per mile. Oil-macadam pavement 6 in. thick and 15 ft. wide cost $0.112 per square foot. Engineering overhead was 3.2% and administration 1.5%. The alignment followed existing roads on section-lines.

Division 9-A was in a rolling to hilly country and was the first where there was any appreciable amount of grading that could not be done with plow and scraper. The alignment followed existing roads for only part of the way, and cost of right-of-way was a considerable item, amounting in all to $10,600. Grading cost $1800 per mile and bridges and culverts $1100 per mile. The cost of engineering was high, 17% on the road and 38% on one section. Administration was 2.5%. This highway was not surfaced or paved. The average distance from a railroad was 15 miles.

Division 9-B was in a rolling country near a railroad. Grading cost $1000 per mile and bridges and culverts $1600 per mile. Concrete pavement cost $0.13 per square foot. Engineering overhead was 5% and administration 2%. The alignment following existing roads.

The first two sections of division 10, extending from Bakersfield to Sivert, were in a level country and followed existing roads, which were parallel to a railroad. Grading cost $600 per mile and culverts about the same. The first section was paved with concrete 5 in. thick and 16 ft. wide, costing $0.107 per square foot. The next section was surfaced with broken stone at a cost of $0.066 per square foot. Engineering overhead was 3% and administration 1.8%. Two other sections of this highway, from Magunden south and thence east to the State highway, while nominally classed with this division, really formed a separate highway. These two sections ran through a level country and followed existing roads on section-lines. Grading cost $1200 per mile and culverts and bridges $400 per mile. Part of the concrete pavement was 4½ in. thick and 16 ft. wide and cost $0.132 per square foot, while the remainder was 4½ in. thick and 12 ft. wide and cost $0.181 per square foot. Engineering overhead was 3% and administration 2%. The remainder of division 10, extending from Sivert to Mojave, 56 miles in all, is mainly in a rough mountainous country. For part of the distance existing roads were followed, but the total cost of right-of-way amounted to $10,500. The highway is within a mile of a railroad for practically the entire distance. Guard-fence is a considerable item of expense, amounting in all to $10,000. Grading cost $3800 per mile and bridges and culverts $1700 per mile. Engineering overhead was 10.6% and administration 2.2%.

The funds available permitted the improvement of only a part of division 11. From Caliente northerly for 10.6 miles, grading was completed, while some improvement was made for the next 8 miles. Grading cost $5500 per mile and bridges and culverts $750 per mile. Engineering overhead was 5.5% and administration 2%. This highway ran through a rough mountainous country and followed existing roads for only part of the distance. The average distance from a railroad on the part that was graded completely was five miles.

Division 12 was in a rolling and hilly desert country. Grading cost $1900 per mile and bridges and culverts $900 per mile. The broken-stone surface cost $0.041 per square foot. The engineering overhead was 12.3% and administration 2.3%. The alignment followed existing roads for part of the distance. The average distance from a railroad was four miles.

The comparative cost of the various types of surface was as follows: Broken stone, which was practically water-bound macadam 6 in. thick, cost from $0.041 to $0.066 per square foot, the average being $0.056. Oil-macadam pavement 6 in. thick and 16 ft. wide was laid on only two roads, the costs being $0.09 and $0.112 per square foot, respectively. The cost of concrete pavement 4½ in. thick and either 15 or 16 ft. wide ranged from $0.11 to $0.158 per square foot, the average being $0.136. An eight-mile stretch of concrete pavement 4½ in. thick and 12 ft. wide cost $0.181 per square foot. The average cost of three stretches of concrete pavement 5 in. thick and 16 ft. wide, 25 miles in all, was $0.132 per square foot.

There was a wide variation in the engineering overhead expense. On some of the highways, particularly those that followed existing roads on section-lines, it was as low as 2.5 to 3%, while on one mountain section 5.4 miles long, it was as high as 38%. The average for the entire system was 5.5%. The range in cost per mile of highway for engineering is not so great, the lowest being $250 and the highest $950, with an average of $450 per mile. The administration overhead did not vary much from 2% on any part of the system.

Electric annealing is being used at Brea, California, by the Bardeen Corporation for restoring crystallized oil-well casing and rotary drill-pipe, particularly the latter. One joint is treated at a time. It takes about 15 minutes for the electric current to heat 6-in. pipe to the required temperature. A pressure of 600 lb. per square inch is applied to the ends of the pipe during this period.

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AMERICAN BIG GUNS

Artillery may be divided into two classes: mobile artillery, which includes all guns used in the field, and sea-coast artillery, which is used in fortifications on fixed mounts. Mobile artillery is divided into three distinct types, guns, howitzers, and mortars.

Guns. The first of these are long-range rifles distinguished by high muzzle-velocity and long barrels of from 30 to 50 calibres; that it to say, the length of barrel is thirty to fifty times the diameter of the bore, giving a range of from 6000 to 30,000 yd. with a low angle of fire. These guns are classified as wheel-mounts, anti-aircraft (truck-mounts), emplacement-mounts, and railway mounts. The wheel-mounts are subdivided into pack-artillery (mountain guns transported on pack-mules); field-guns, drawn by horse-teams and attached to rumbles; motorized field-guns, drawn by big ammunition trucks; tractor-drawn guns of large calibre; and the so-called horse-artillery, drawn by horses, with all cannoneers mounted, for fast field-work in support of cavalry. The wheel-mount guns include the famous French 75 (3-in.) and the 4.7-in. guns, which have created such havoc among their German opponents and which have been responsible for breaking down the greatest military offensives of the Germans in the past three years. The 4.7-in. are of greater range and calibre but of practically the same type as the 75-mm. Next in order, according to size, come the 5-in. and the 6-in. sea-coast guns, such as our Allies have withdrawn from the fortifications and mounted on improvized wheel-mounts, for use as mobile artillery.

The second class are the anti-aircraft guns, for which purpose 75-mm. and 4.7-in. guns are provided, mounted on a carriage which will allow an elevation of about 85° and a traverse of 360°, set up on a motor-truck. Emplacement-mounts are large-calibre guns that are partly mobile. They are taken apart and moved around in sections on tractors as needed, and set up in concrete emplacements. They are, strictly speaking, siege-guns. The railway-mount guns are converted sea-coast and naval long-range rifles of 8 to 14-in. calibre. They have a mount consisting of a specially designed carriage on a railway car and they are operated, due to their extreme range and accuracy, far back from the front lines over the heads of our own troops.

This covers the first class of mobile artillery—the long-range rifles. Next in order come the howitzers.

Howitzers. The howitzer is distinguished from the rifle by a low muzzle-velocity, ranging from 1200 to 1900 ft. per second, and a short barrel, approximately eighteen times the calibre of the gun, developing a range at high angle fire of 10,000 to 23,000 yd. The commonest sizes of howitzer in use are the 155-mm., the 8-in., the 240-mm., and the famous 16-in. howitzer, about which we heard so much in the early days of the War, when the Germans, who first used them, created such dreadful havoc, destroying with them the fortifications of Liège. The smaller sizes, such as the 155-mm. and the 8-in., are used principally for field-work, but also for bombardment of permanent fortifications when necessary.

Howitzers have the advantage of being cheaper to make than guns, and use cheaper ammunition. Also the life of the gun is longer. The life of a howitzer is about two-thirds longer than a gun of the same calibre. They are, however, not as accurate and have not as long range as the guns and consequently are not adapted for all work.

The life of the guns ranges from 8000 rounds for the small field type to 600 or 700 for the converted sea-coast guns. These figures denote only the actual accuracy life. It is probable that the guns will be fired about 50% more times than these figures before retiring them. Re-lining the barrel renews the gun for all practical purposes.

Mortars. Mortars have an even lower muzzle-velocity, from 480 to 2000 ft. per second, and a length of barrel of about 10 calibres, with a range of 2500 to 15,000 yd. This extreme range is obtained by a high angle of elevation. The common French type is the 240-mm. mounted on a railway carriage.

An etchograph or electric pencil for writing or drawing on steel is described in the 'Scientific American'. A small step-down transformer is energized by putting the terminals in a lamp-socket. With a circuit of 110 volts and 60 cycles, currents of 1.5 ampere are transformed to 20 amperes and 2 volts. The current is brought to a metal clamp on the pencil, the other connection being made to the piece of steel to be marked. The pencil is of copper, and the holder is made of ebonite. The depth of the marking can be adjusted by a rheostat. Milling-cutters, taps, drills, and saws can be marked in this way. This easy distinctive permanent marking of small tools should be welcome in the workshop.

The minimum cost of construction of steel-wire transmission-lines is said to be reached with 35-ft. poles at intervals of 250 to 300 ft., using No. 4 wire. With wires of this size no trouble from rusting within a reasonable time is anticipated. A difficulty that has been experienced in some cases is the high charging-current, values as much as three times the full-load current being encountered, together with a power factor of only 13%. This trouble is partly attributable to the use of steel poles, and there seems reason to expect better results in this respect when the supports are of wood. —'Mechanical World'.

Lighthouses and other aids to navigation maintained by the U. S. Commissioner of Lighthouses on June 30, 1917, numbered 15,223 in all, of which 5420 were lights of all classes and 588 were fog-signals. The lighthouse service maintains aids to navigation on 47,192 miles of coast-line and river-channel. During the fiscal year 50 tenders and 68 light-vessels were in commission.

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The Oxy-Acetylene Process for Welding Boiler-Plate*

The chemistry of oxy-acetylene is well known, but not until recent years have boiler-makers and users felt justified in using the oxy-acetylene torch for patching boilers. Considerable experience in handling the torch is needed by the operator in order to avoid burning the metal. In 'lining-out' a pattern from a boiler-plate, we in America can do tolerably well; but to make a good serviceable joint out of two pieces of metal that have been subjected to the stresses incident to the operation of a steam boiler, we realize the extent of the problems involved and the skill required for a successful weld.

Attempts have been made at producing a joint between two pieces of steel, using a third piece as the welding medium. Since a small divergence in the chemical composition, or even in the mechanical structure of the third element, affects the cohesive power of the weld, it is hard to obtain a weld that will show anywhere near the tensile strength of the original plate. What may be said of welding is also true of a riveted seam within certain limits. The average oxy-acetylene weld has an efficiency of about 70%, although tests have been made in which the efficiency was much higher. This compares well with a double-lap riveted joint.

Below is a table of tests made of three pieces taken from new boiler-plate.

Plate No.	Copper, %	Variation thickness, inches	Tensile strength, lb. per sq in.	Load at failure, lb.
1	0.03	0.02	60,000	99,270
2	0.03	0.012	60,000	77,320
3	0.03	0.024	60,000	68,820

Fracture of plate:

1, small, well defined crystals, close grained.
2, coarse grained, spongy, well knit.
3, coarse, fibrous, loose and open.

Plate No. 1 was ½ by 3 by 15 in. The characteristic constituents were modified to some extent by 0.03% copper. The bar was cut from a boiler-plate open-hearth steel flange, 60,000-lb. tensile strength, and placed in a planer and finished to size. The variation in thickness was 0.02 in. The plate was placed in an Olsen testing machine of 200,000 lb. capacity. The plate broke at 99,270 lb. Plate No. 2 was cut from the same sheet, welded, and placed in the machine. The weld broke at 77,320 lb., which shows the efficiency of the welded joint was about 77%. The fractures of the original plate showed irregular homogenous crystallization, small and definite. In the welded joint, in which were used the shavings from the same plate, the crystals at the point of fracture through the weld were somewhat larger and more irregular than in the original plate. In the third test conditions were identical with the two preceding, except for the use of ordinary bessemer steel welding-rods. This weld showed the least strength, although apparently as much pains were taken to make the weld as nearly identical in method and size as in case of the first test.

This shows that the welding-steel should be as nearly as possible the same composition as the plates on which it is to be used. In many instances operators have used foreign compositions, and built up a weld which was supposedly strong, but, because of high or low carbon, or even a small proportion of manganese or copper, the weld was not such that it would properly knit with the adjoining plate. In fact, there have been instances in which ordinary wrought-iron was used for welding a steel plate. Spring steel has also been used on ordinary flange-steel boiler-plate, perhaps on the assumption that the steel having higher tensile strength would make a better joint than the homogenous steel could possibly make. A high carbon steel in connection with a low carbon plate will not make the same mechanical joining that a high carbon steel in a high carbon plate would. Unless some effort is made to get steel of nearly the same chemical constituents, we cannot hope to produce good welded joints.

If a weld is made with metal of the same composition as the sheets to be welded, and if time is allowed for the gradual heating of the sheets before the welding-metal is introduced and the welt is built slowly from the bottom of the sheet to the surface there is nothing to prevent a good weld that will give a high degree of efficiency. In the majority of cases the rapidity with which the molten metal is run into the seam is the feature that prevents a homogenous joint. Sufficient time is not given for the metal to set, knit, and re-crystallize with the edges of the sheet.

The etched surfaces of the broken welds fail to reveal any of the objectionable features that have been urged against oxy-acetylene welding for repairing boilers. Of course we must reckon with the human factor in all work. That is no less true in riveting than it is in welding. The human factor has not, in America at least, been brought to a realization of the underlying features, chemical and mechanical, which are very necessary to the production of a good joint. Quick repairs require that the oxy-acetylene process be improved considerably. Repairs on large castings, and even on frames of large locomotives, have been made with thermit; but the disadvantages of thermit are the advantages of oxy-acetylene welding, and the preponderance of metal at any given point is not always the proper thing to have. Especially is this true with fly-wheels, which would thus be thrown considerably out of balance, and it is also true of large engine-frames which have not the proper

*Abstract of article in 'California Safety News,' by Howard L. Boyd, mechanical engineer, Industrial Accident Commission of California.

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form to permit their being enlarged at a given place without throwing out the continuity of the lines and maintaining clearances.

Fig. 1 shows a welded fire-crack from the girth-seam of a 66-in. boiler. The plate is 13/32 in. thick, the pitch of the rivets is $2\frac{1}{2}$ in., the rivets are $\frac{7}{8}$ in., in a $\frac{15}{16}$-in. hole. Fire-cracks developed on this seam, extending back to the shank of the rivets. It was expected that repairs would have to be made by putting in a new sheet. The oxy-acetylene torch was used instead. The plate was 'V'd' in front of the rivets to give good metal with which to knit. A piece of plate with approximately the same tensile strength and composition as the shell-plate was used as a welding medium. After cutting out the old rivets in the seam, the sheets were heated to a dull red, and fresh metal run by the acetylene torch into position in front of the rivet-holes. There was no 'building up' beyond the thickness of the plate and beyond the position of the edge of the original plate. After cooling, the edge of the plate was chipped, the holes reamed, the rivets driven, and the seam calked with a blunt-nosed tool, and the boiler was put under pressure. It has operated successfully, the fire cracks have not developed weakness, in spite of the fact that the flame from the burner is a little high, thereby impinging against the edge of the plate, and having a tendency to produce additional fire-cracks. The seam is almost as efficient as when it was new. The plate, being homogenously welded with other plate of about the same chemical constituents, the knitting has been such that we can expect best results consistent with the condition of the sheet at the outset. Fig. 2 is the front view of a welded fire-crack after re-driving rivets, the chalk-line showing the margin of the heated area.

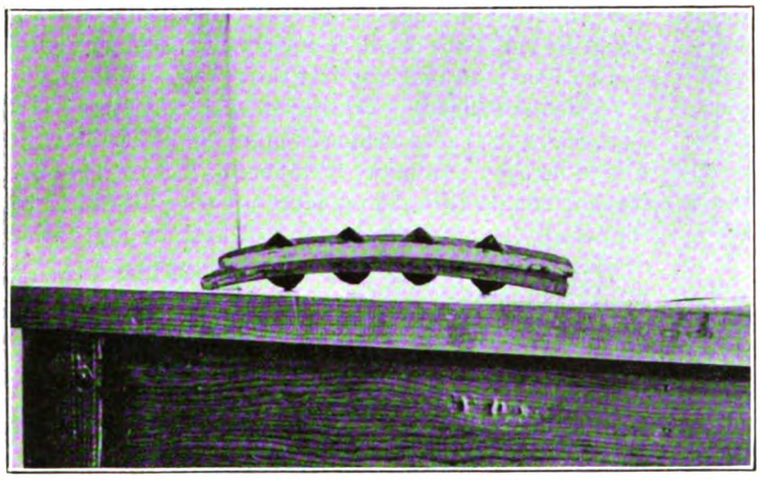

FIG. 1. SIDE VIEW OF WELDED FIRE-CRACK

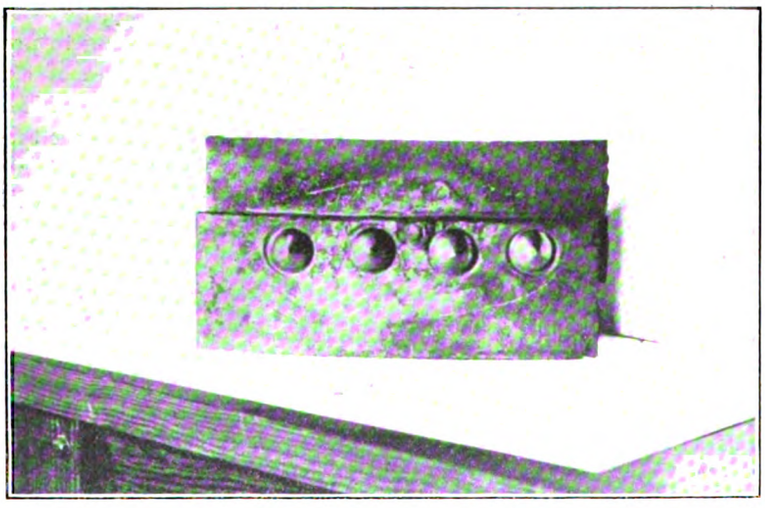

FIG. 2. FRONT VIEW OF WELDED FIRE-CRACK

Fire-cracks usually burn the edge of the sheet to a beveled edge, so that not only the edge of the sheet oxidizes and crystallizes but oxidation and crystallization extend back into the rivet. This is especially true on the surface of the sheet itself. Therefore it is necessary in such cases of welding to remove the rivet, 'build up' the sheet to the required thickness, re-drill to approximate size, and ream. If proper precautions have been taken to prevent the weld from becoming too thick, the rivets can be driven into what might be considered the original sheet, without any undue stresses developing because of unevenness of the sheet. There are few fire-cracks that cannot be repaired by the oxy-acetylene torch.

The ultimate strength of wrought-iron increases with the temperature to a maximum at about 430° F. It then decreases until at 1000° F. it is about half that at ordinary temperatures. The elastic limit does not show much variation until a temperature of 400° F. is reached. From this point it decreases rapidly. At 600° F. it is one-half and at 1000° F. one-third of what it is at ordinary temperatures. Elongation, which was 20% at ordinary temperatures, decreased to 10% at 250° F., increased to 15% at 600° F., then decreased again to 10% at 900° F. The experiments on which these results are based were made by F. A. Epp and E. C. Jones and were reported in 'Metallurgical and Chemical Engineering.'

Central-station development on a large scale has been proposed in Great Britain. The plan calls for replacing over 600 plants now generating current for power purposes by 16 large stations, with outputs varying from 20,000 to 50,000 horse-power. These stations are to be in the coal-producing districts or else at points having ample rail and water facilities for transporting coal. The plan also provides for the extraction of various by-products from the coal and for the establishment of electro-chemical industries near the power-stations.

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Testing an Air-Compressor

By WALTER S. WEEKS

When a compressor is sold it is guaranteed to have a certain volumetric efficiency by orifice test.

This efficiency is determined as follows: The air delivered per minute by the compressor is measured. The volume of this air is calculated under the conditions that prevailed at the intake of the compressor. This volume is divided by the volume swept per minute by the piston of the low-pressure cylinder. The result is the efficiency sought. The piston rod should be neglected.

The term volumetric efficiency is also used in comparing the performance of a compressor at different altitudes and with different intake temperatures. This use of the term is in my opinion unnecessary and confusing. The whole subject may be clarified by using the term 'volumetric efficiency' only for that given by the orifice test and stating the air-consumption of tools in cubic feet of compressed air at a given gauge-pressure.

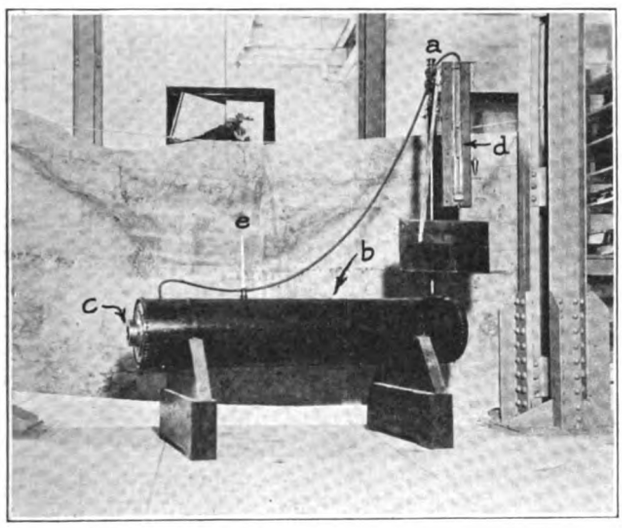

FIG. 1. COMPLETE AIR-METER

An example, if I may digress for a moment, would be something like this: An air-drill requires 10 cu. ft. of compressed air at 90-lb. gauge. The altitude is 10,000 ft. The temperature of the mine is 100°F. The temperature of the compressor-room is 60°F. What must be the displacement of the low-pressure cylinder to run 10 drills? The volumetric efficiency of the compressor by orifice test is 80%.

Compressed air needed $10 \times 10 = 100$ cu. ft.

Ratio of compression at 10,000 ft. $= \frac{90 + 10}{10} = 10.$

Free air needed $= 10 \times 100 = 1000$ cu. ft.

1000 cu. ft. is needed in the mine at 100°F. It is 60° in the compressor-room, so the free air at the temperature at the compressor-room is $\frac{520}{560} \times 1000 = 929$. The compressor will deliver, at this altitude, according to the maker, only 80% of the piston-displacement, hence the displacement needed is $\frac{929}{0.8} = 1161$ cu. ft.

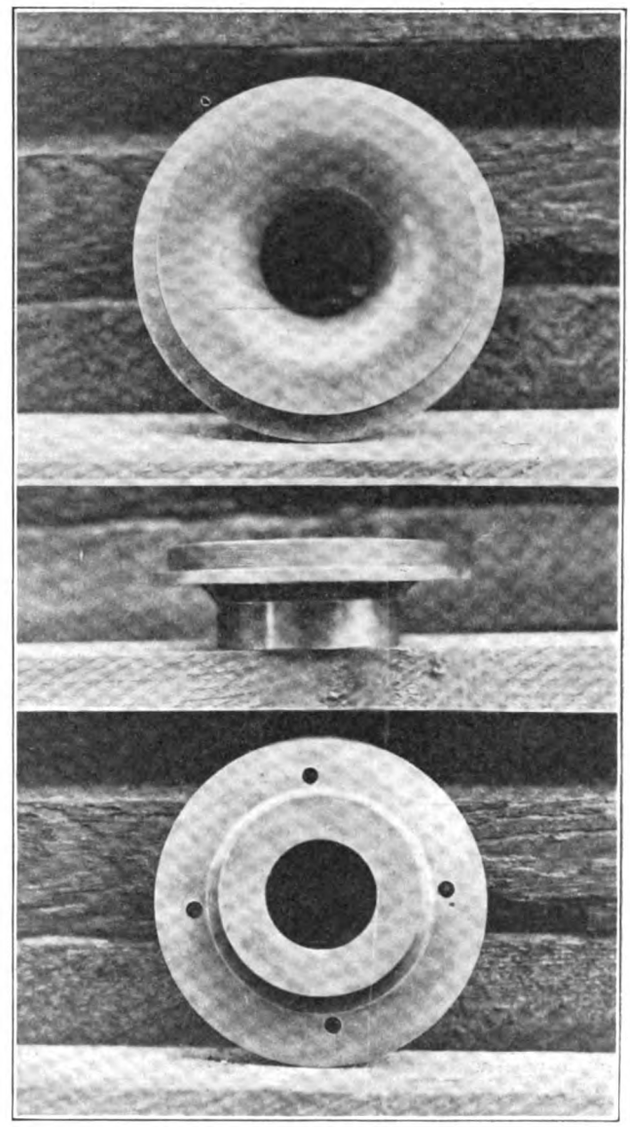

FIG. 4. THE NOZZLE

The vital questions about an air-compressor are: How much does the compressed air cost, and is the compressor doing all that it should?

To answer these questions we must measure our power input, we must measure the air delivered, we must take

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indicator-cards on the air end, and determine the displacement.

The measurement of power on the driving side is familiar to all, but a rapid way of measuring the air may not be quite so familiar. The air is best measured by what is known as the low-pressure orifice method (Fig. 1). All the compressed air that the compressor will make is discharged from the receiver through a valve *a* into a tank *b* in which is placed a nozzle or orifice *c*. The valve is closed until the compressor will just hold the receiver pressure desired. The pressure just back of the nozzle is taken with a water manometer *d*, and its temperature is taken with a thermometer *e*. From these data, with the size of the nozzle, the air flowing per minute may be computed.

The flow through an orific is assumed to be adiabatic, but an adiabatic formula is cumbersome. If we assume that the density of the air is a mean between the density inside and outside the tank, a simple formula can be developed from the basic principle that $V = \sqrt{2g\,H}$. This simple formula agrees with the adiabatic formula up to 18 in. of water. A discussion of the development of the simple formula may be found in 'Engineering Thermodynamics,' by C. E. Lucke.

The formula there given is pounds of air per second through a circle of

$$d \text{ in. diam.} = 0.01366\, d^2 \sqrt{\frac{h_w P}{T}} \text{ (No. 1).}$$

d = diam. of nozzle in inches.

h_w = difference in pressure on the two sides of the nozzle in inches of water (never over 18 in.).

P = mean pressure on the two sides of nozzle in lb. per sq. ft.

T = absolute temperature back of the nozzle in degrees F.

What we are after is the cubic feet of free air delivered per minute under intake conditions. Curves may be plotted to make our computations easy.

To find the weight per minute multiply by 60

$$W = 0.81960\, d^2 \sqrt{\frac{h_w P}{T}}$$

First assume the nozzle to be 1 in. diam., the nozzle temperature 60°F., the barometric pressure 14.6 lb. per sq. in., and determine the weight that will flow out per minute with water-gauges from 1 to 15 inches.

After these weights are determined, calculate the volumes under a standard set of conditions by the formula

$$V = \frac{w\,R\,T}{P_s}$$

V = volume in cu. ft.

w = weight in lb.

R = 53.34

T = absolute temperature = 520°F.

P_s = absolute pressure in lb. per sq. ft. = 14.6 × 144 = 2102.4.

We now have the data for curve *A* (Fig. 2). The values plotted include a coefficient of flow for the nozzle of 0.98, which from various investigations appears to be reasonable.

Now suppose the nozzle temperature instead of being 520° abs. is some other temperature T_1 abs. We can determine the flow by multiplying the values on curve *A* by $\sqrt{\frac{520}{T_1}}$. The air after making this correction will still be measured at 60°F. This correction is plotted in curve *B*.

Now suppose the barometric pressure is not 14.6 but some other pressure P_1 lb. per sq. in. In formula No. 1 P is the average pressure in lb. per sq. ft. Let Pm_1 be the average pressure in the same units when P_1 is the

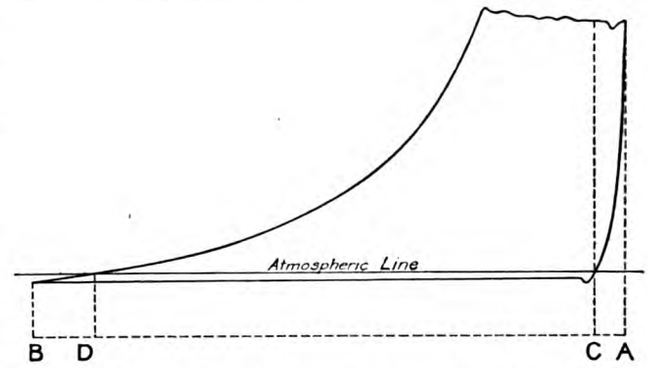

FIG. 3. LOW-PRESSURE INDICATOR-CARD

barometric pressure. The flow of air when the barometer is P_1 may be obtained by multiplying values from curve *A* by $\sqrt{\frac{Pm_1}{P}}$

Without appreciable error we may use the ratio of barometric pressures instead of the average pressures. So we may multiply by $\sqrt{\frac{P_1}{14.6}}$ instead of $\sqrt{\frac{Pm_1}{P}}$

After making this correction the air would still be measured at 14.6 lb. per square inch. We want the volume at pressure P_1 so we must multiply by $\frac{14.6}{P_1}$; thus the total correction will be $\frac{14.6}{P_1} \times \sqrt{\frac{P_1}{14.6}} = \sqrt{\frac{14.6}{P_1}}$

This correction forms the basis for curve *C*. I have used inches of mercury for the barometer pressure because most aneroid barometers read this way.

After making the corrections for nozzle temperature and barometer we have the air at 60°F. and at the barometric pressure existing. There remains still to compute the volume at the intake temperature. This correction is merely the ratio of the absolute temperatures and is plotted in curve *D*.

The final result must be multiplied by the square of the diameter of the nozzle in inches.

Example of the use of the chart.

Nozzle 2 in. diam.

Water column 8 in.

Nozzle temperature 80°F.

Barometer 30 in

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Intake temperature 90°F.

Curve *A* 60.6 cu. ft. at 14.6 lb. per sq. in. and 60°F.

Curve *B*, 0.981.

Curve *C*, 0.995.

Curve *D*, 1.058.

Square of diam., 4.

Total correction, $0.981 \times 0.995 \times 1.058 \times 4 = 4.131$.

$4.131 \times 60.6 = 250.34$.

The nozzle then is discharging each minute 250.34 cu. ft. air at 90°F. and 30 in. of mercury. This figure divided by the displacement gives the volumetric efficiency.

Let us suppose that we are testing a two-stage compressor driven by a belt-connected induction-motor.

An indicating wattmeter gives the power-input.

The air-cylinders should be fitted with indicators.

Tests should be run at various gauge-pressures. Let us suppose we are running a test at 90-lb. gauge.

All gauges should be calibrated. Discharge all the air that the compressor makes through the nozzle and adjust the valve to the tank till a pressure of 90 lb. is maintained in the receiver. Let the compressor run under these conditions for 15 minutes. Read wattmeter, water column, nozzle temperature, intake temperature, barometer, r.p.m., and take indicator-cards.

The horse-power calculated from the indicator-cards divided by the horse-power input gives the over-all mechanical efficiency.

From the cost of power, the kilowatt input, and the air delivered, may be calculated the cost of compressed air per unit.

The air delivered divided by the displacement of the low-pressure cylinder gives the volumetric efficiency.

With the aid of the low-pressure indicator-card we can determine the slippage.

The actual volume of air taken in each stroke at atmospheric pressure is represented by the length of the atmospheric line included in the indicator diagram. Glancing at Fig. 3: if *A B* represents a displacement volume *K* then the volume of air taken in each stroke at atmospheric pressure is $\frac{CD}{AB} \times K = L$.

Less air is taken into the crank end of the cylinder

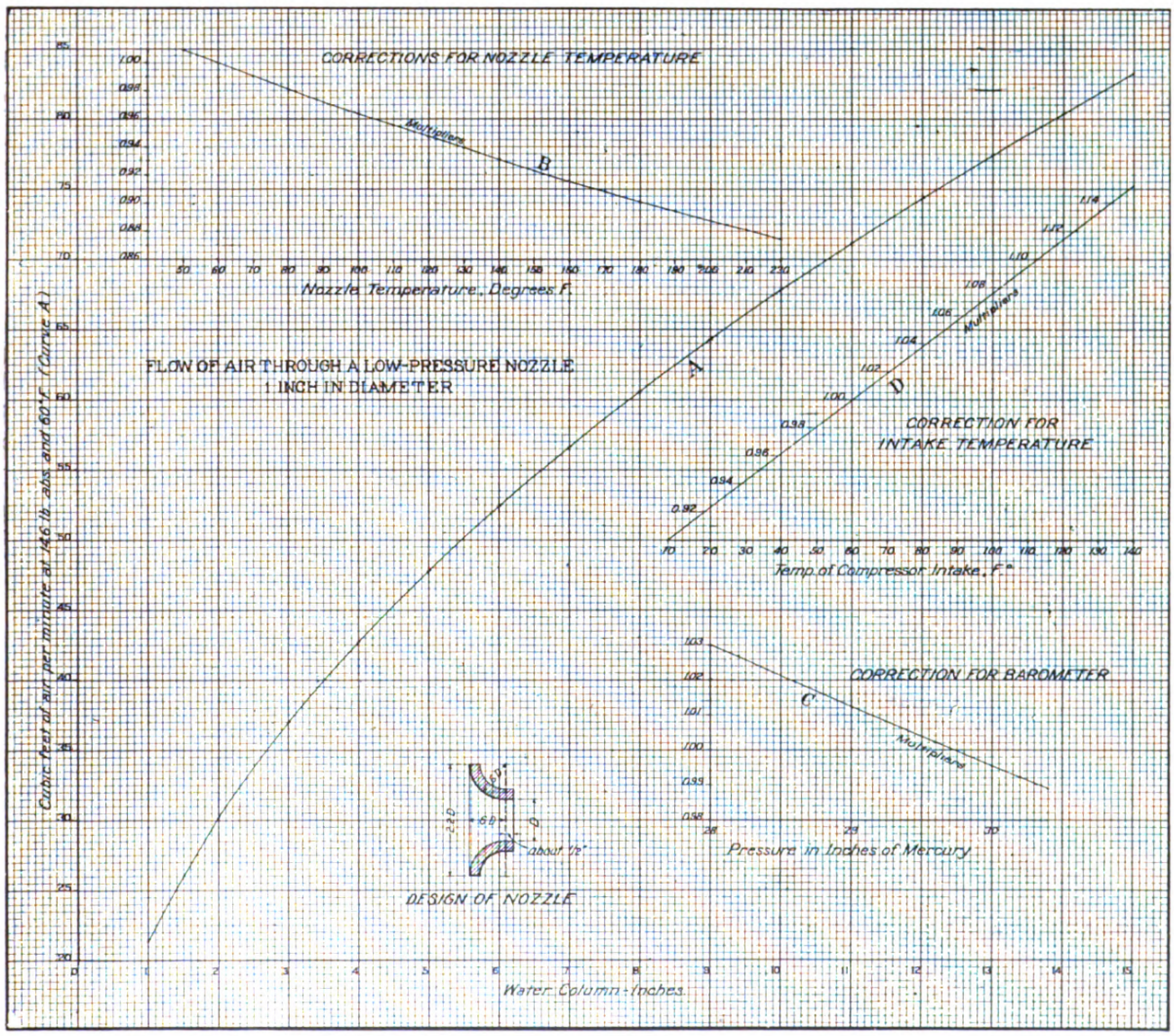

FIG. 2. CHART OF NOZZLE-DISCHARGE

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than into the head end because the piston-rod takes up room; therefore the displacement of each end must be figured separately.

Let L_1 = volume at head end at atmospheric pressure.

Let L_2 = volume at crank end at atmospheric pressure.

Let S = r.p.m.

Then the number of cubic feet of air that actually enters the compressor each minute at atmospheric pressure is $(L_1 + L_2)\ S = M$.

The air delivered as measured by the nozzle divided by M gives what is called the slippage efficiency. It is assumed that the air is not heated on its way into the compressor. The air must be warmed somewhat, just how much in a fast-running compressor, I don't know. A little study will show that the warming of the air will make this efficiency appear lower than it really is. Even if the method is not rigidly accurate, it will detect leakage by the piston and through the valves.

S. B. Redfield, testing engineer for the Ingersoll-Rand Co., to whom I am indebted for much information, has used a similar chart for many years in testing the many compressors turned out by the plant, and has found the method most satisfactory. On the chart is a sketch of the nozzle adopted by Mr. Redfield. Fig. 4 is a photograph of a nozzle. A casting should be made of brass and the nozzle threaded to screw into the tank. The nozzle should be polished. For a test a nozzle should be selected to keep the water gauge less than 15 inches.

The area of the tank should be twenty times the area of the nozzle. An even flow through the tank is desired. The globe valve admitting air to the tank may be made delicate by fastening a long lever to the handle. When a compressor is purchased, specification should be made that it be tapped for indicators. These holes are handy in testing the tightness of valves and pistons.

It would be an excellent idea if the makers of air-compressors would agree on a standard method of testing. As the case stands at present a comparison of guarantees is impossible because the compressors are tested by different methods. The important guarantee of a compressor is the horse-power input per 100 cu. ft. air delivered. The way that the air is measured should be carefully scrutinized.

In order that curve A may be plotted to a more open scale, I append the values from which it is plotted.

Water-column in inches	Cu. ft. of air	Water-column in inches	Cu. ft. of air
1	21.32	9	64.28
2	30.17	10	67.79
3	36.97	11	71.15
4	42.72	12	74.36
5	47.79	13	77.44
6	52.39	14	80.41
7	56.62	15	83.28
8	60.57		

Gold holdings of Japan on December 15, 1917, amounted to Y1,093,000,000, of which Y631,000,000 is held abroad (1 yen = 50 cents).

DEEPEST WELL IN THE WORLD

The deepest well in the world, already 7363 ft. deep, is now being drilled on the Goff farm, 8 miles north-east of Clarksburg, West Virginia. Until January 24 the record had been held by a boring at Czuchow, Silesia, 7349 ft. deep. The drilling is still in progress and sufficient length of cable and adequate power and tools are at hand for driving still farther into the crust of the earth. The depth of this well exceeds the height of Mount Washington (6293 ft.), and it is over half a mile deeper than the Grand Canyon of the Colorado in Arizona. The well goes farther down than the deepest mines in Michigan, Brazil, or Europe. Several oil-wells in California, in the South-West, in West Virginia, and in Pennsylvania have exceeded 4000 ft. in depth, and one near McDonald, Pennsylvania, 14 miles west of Pittsburgh, reached 7248 ft. below the surface. C. E. Van Orstrand, of the Geological Survey, found that at a depth of 7000 ft. in the well the temperature is 152° F. and that the rate of increase at this depth is about 1° in every 51 ft. This shows that the outer crust of the earth in this region is relatively cool, for in many other regions the temperature increases more rapidly. Mr. Van Orstrand estimates that the temperature of the rocks beneath the Goff well will be found at the boiling point (212° F.) at a depth somewhere around 10,000 ft. The Goff well is near the centre of the great Appalachian coalfield basin, or trough, and is being drilled in search of deeper oil-sands than have yet been reached in this part of the basin. The most hope is based on the Clinton sand, a formation of Silurian age, which is prolific of gas and oil across central Ohio from Cleveland nearly to the Ohio river. From its outcrop this formation dips gently to the south-east beneath younger formations. If the drill can reach the Clinton sand beneath the Goff farm, which is on an anticline in the shallower strata, it may find gas or oil under tremendous pressure. If the well strikes a valuable oil or gas pool in the Clinton sand in this part of the basin it may lead to the development of new reserves that may open a new era in the history of the Appalachian oil and gas region.

By-product ammonia from coking is recovered as ammonium sulphate. The present output is 200,000 tons of the sulphate annually. Additions to by-product coking equipment in this country will double the production during 1918. If all coking were done in by-product ovens the quantity of ammonium sulphate available in the United States would be about 700,000 tons per annum.

The phenomenon of life has been shown by Amé Pictet to depend upon that structure of an organic molecule in which the atoms are disposed as an open chain. So far as concerns its chemical relations death is accompanied by a change in the molecule that closes the chain, that is, causes cyclisation of the elements of the protoplasm.

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The Oil-Shale Industry

By ARTHUR J. HOSKIN

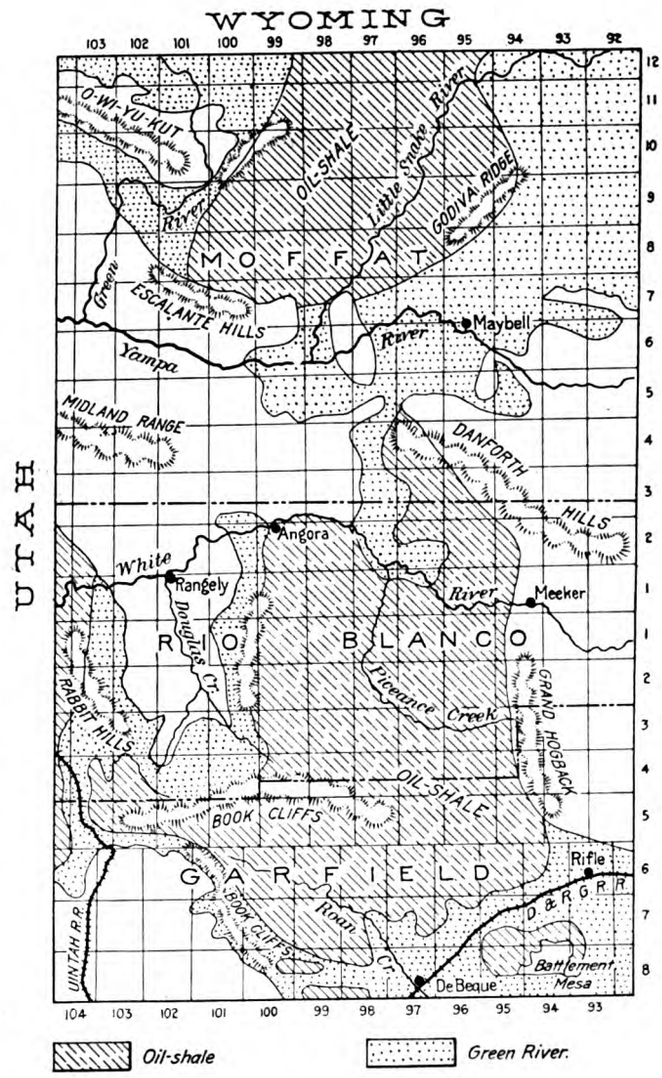
INTRODUCTION. Much is being said about an American industry in the intermountain region embracing portions of western Colorado, south-western Wyoming, eastern Utah, and a part of Nevada. Anyone living in Salt Lake City or Denver is bound to hear of the petroleum in the shale beds of the so-called Green River series. Not only are the professional promoters busy, but staid business men are becoming interested. Government experts have said so many nice things about the oil-producing character of these shales that the present state of affairs is logical.

Any conversation on this subject is bound to include some reference to the mining and treatment of such shale in Scotland, it being assumed that our American shale is analogous to the Scottish. There being no other source of information concerning the cost and system of operation, many writers of prospectuses have offered lengthy quotations from books descriptive of the Scottish oil-shale industry. Petroleum-shale has been worked successfully in Scotland, France, Germany, and New Zealand for years. American shales will doubtless be worked for centuries to come. At the same time, there may be differences just as significant in oil-bearing shales, the world over, as there are in gold ores, and, in my opinion, conclusions drawn from foreign practice should not be applied prematurely to the Rocky Mountains. We hope the Scottish methods will prove exactly suited to our needs, but we shall not know this for a fact until somebody has demonstrated it upon a commercial scale.

The greatest activity in our new industry is noted along the valley of the Grand river, on the so-called western slope of Colorado. The little towns of De Beque and Grand Valley especially feel the impetus accruing from this new development. These towns are on the main lines of the Denver & Rio Grande and Colorado Midland railroads, which, in this region, operate a joint track.

The general elevation of the productive beds is more than 7500 ft. They are in a vast prairie region, which has been largely neglected because of the inability to irrigate lands that, with the application of water, would prove fertile. Along the water-courses agriculture flourishes. Upon maps this plateau country is called Book Cliffs and Battlement Mesa, these being originally one tableland, now separated by the Grand River valley. The tops of these mesas are almost inaccessible from the riverside, the thick beds of shale having the habit of eroding into precipitous cliffs hundreds of feet high. Mt. Logan is an isolated mass that attracts particular attention from travelers by train. It is just north of De Beque.

THE GEOLOGY of this region is relatively simple. The Green River formation is the most recent of the sedimentary series. It lies, thousands of feet thick, above the Wasatch formation, and this, in turn, overlies the Mesa



COLORADO OIL-SHALE AREA

Verde formation, which is known to be coal-bearing. My description will apply particularly to the Grand Valley, but I wish the reader to remember that the oil-shale is extensive geographically and that activities will spring up, probably, wherever there is convenient access to a railroad. The Denver & Rio Grande railroad traverses

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a wide expanse of shale in Utah, and the Union Pacific railroad does the same in Wyoming.

Not all the Green River formation is oil-bearing. For the most part the productive strata are relatively high in the series, in places constituting the top of the tableland. Properties now esteemed most valuable are those so situated as to include the exposure of rich beds upon the faces of cliffs. There is no dearth of such land at present, but there are other economic desiderata that will not long exist in the scramble for ground upon which to establish industrial operations. A fair supply of water seems indispensable. Another essential is accessibility by wagon-road. Roads can be constructed to any property even if they are expensive, but the supply of water is restricted. At present, the search is for thick beds of rich shale lying exposed close to creeks.

Oil-shale is ordinarily discussed in a way to leave an impression that the oil in the rock is ready for extraction. This is, in the main, erroneous. No doubt there are traces of free petroleum in the shale, but the major part of the oil that may be derived from such rock is created during the treatment to which it is subjected. In other words, these sedimentary rocks contain natural substances in proper proportions to bring about, when heated, certain chemical reactions that will produce hydrocarbons. The shale is the compacted ooze of a former fresh-water marsh or sea; it contains the remains of the vegetal and animal life that flourished in that sea. If these organic remains be subjected to heat they will produce oil that is similar, in every way, to the petroleum obtained from wells. There is no alcohol in corn, but the moonshiner knows how to get 'licker' from it; likewise there is no free oil in shale, although it is a simple matter to put some shale into a gold-miner's retort and produce oil at the gooseneck. The richness of oil-shale, then, depends upon its content of organic remains. In Scotland these substances in the shale go by the name of 'kerogen,' a maker of kerosene. This scientific fact being understood, it is permissible to speak of the shale as 'oil-bearing,' although strictly we should say 'oil-yielding.'

The shale lies nearly flat and is without faulting over large areas. The barren and the enriched strata alternate, and, whereas the thickest and the richest layers are among the most recent, there are frequently thin seams of rich shale in the lower part of the series. These thin seams do not attract attention at present.

A splendid description of these deposits is given in Bulletin 641-F of the U. S. Geological Survey; this, if not out of print, may be obtained gratis upon application at Washington or at the other distributing offices of the Survey, for example, at Denver and in San Francisco. Although the beds lie, as stated, relatively high in the present Green River formation, they probably were originally approximately in the centre of the series.

The productive strata are generally darker in color and lighter in weight that the lean ones. The richer the shale, the less is its specific gravity. The variation in kerogen content does not, however, always correspond to the color of the rock, rich shale sometimes having a brown instead of a black hue. As the many strata in the face of a cliff are viewed from a distance it is impossible to distinguish the lean from the rich. Although there are apparent differences in shade, it does not follow that the darker streaks represent the richer zones. The richest beds have become sufficiently altered by weathering to present a yellow or gray tint that closely matches the adjacent leaner strata. If, however, a prospector's pick be driven into an outcrop, the shale is quickly differentiated as to grade, because the weathering of the oil-yielding rock does not usually extend more than a fraction of an inch deep.

When one becomes familiar with these shales he learns another characteristic that can often be utilized in long-range investigations, namely, the richer the shale the better it has withstood climatic agencies, so that it often forms a slightly projecting shelf above a sheer cliff of lean rock. The productive strata in weathering do not usually create cliffs nearly as steep as do the leaner strata; consequently they generally outcrop as sloping walls above and perhaps below vertical precipices. This is held to be an economic advantage inasmuch as it will afford a foothold during quarrying operations.

Varieties of Shale. The oil-yielding shales where they outcrop exhibit two kinds of structure, known as the 'paper' and the 'massive.' The paper shale splits into thin sheets resembling leaves, whence the name Book Cliffs, whereas the massive shale, although showing primary stratification, breaks with an irregular fracture, often conchoidal. Another difference has been asserted, namely, that the paper shale contains more paraffine than the massive. This observation has yet to be confirmed. Horizontal excavations into the paper strata usually encounter the massive shale within a short distance, indicating that the papery characteristic is only a phase of weathering.

It has been found, by preliminary research, that there is a decided difference between the properties of the two kinds of shale when subjected to heat in retorts, the massive shale having a strong tendency to form a pasty mass, especially if heated rapidly, whereas the paper shale remains in separate fragments. This has led to the assumption that a process efficient with one kind may not work successfully with the other; so the question has arisen as to what process, if any, will succeed with both kinds of shale. One company has constructed a still with the intention of handling only the paper shale that outcrops abundantly upon its property. It has succeeded in treating this shale in a small retort and is planning to erect a larger plant. Some concerns are preparing to exploit the massive shale only, while others propose to mix the two kinds as they are quarried or mined.

Methods of Distillation. Much research is being devoted to the distillation of the oil-shale. Many persons are positive that the Henderson, Pumpherston, or Young & Fyfe processes, all Scottish, or slight modifications thereof, will prove the ideal treatment for American

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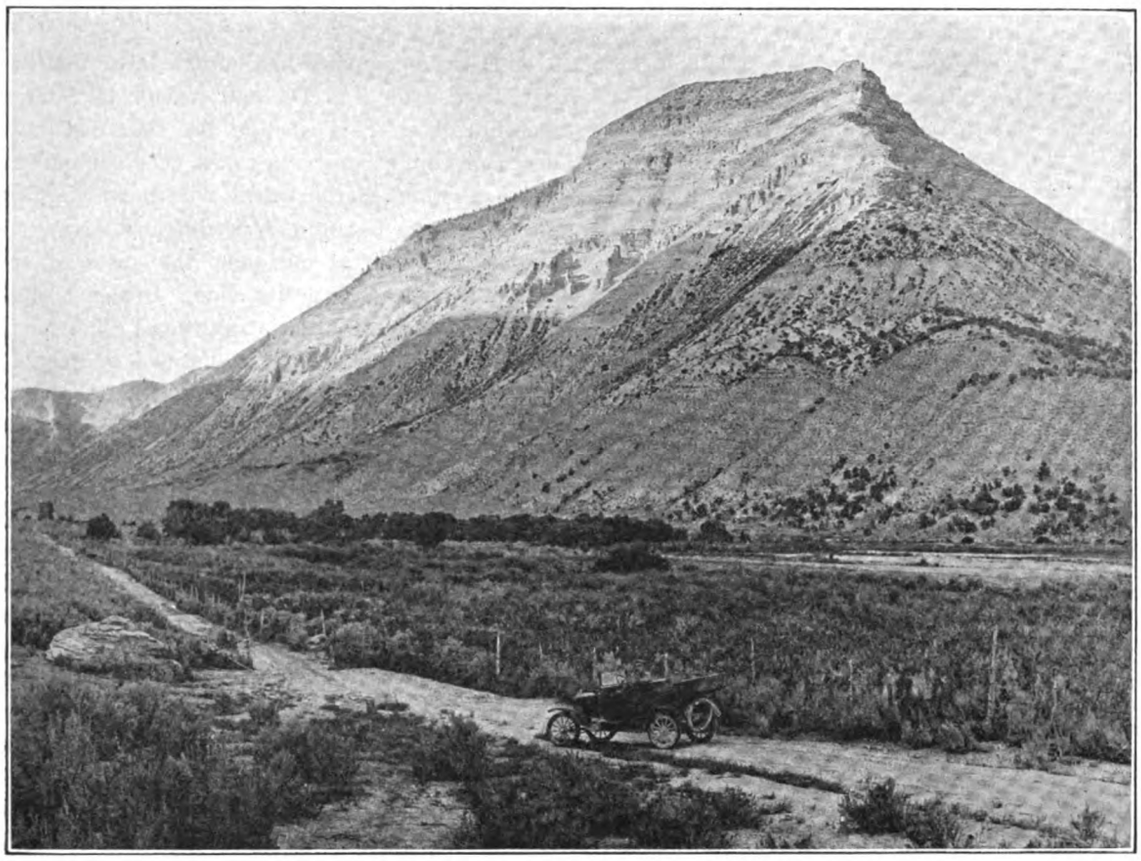
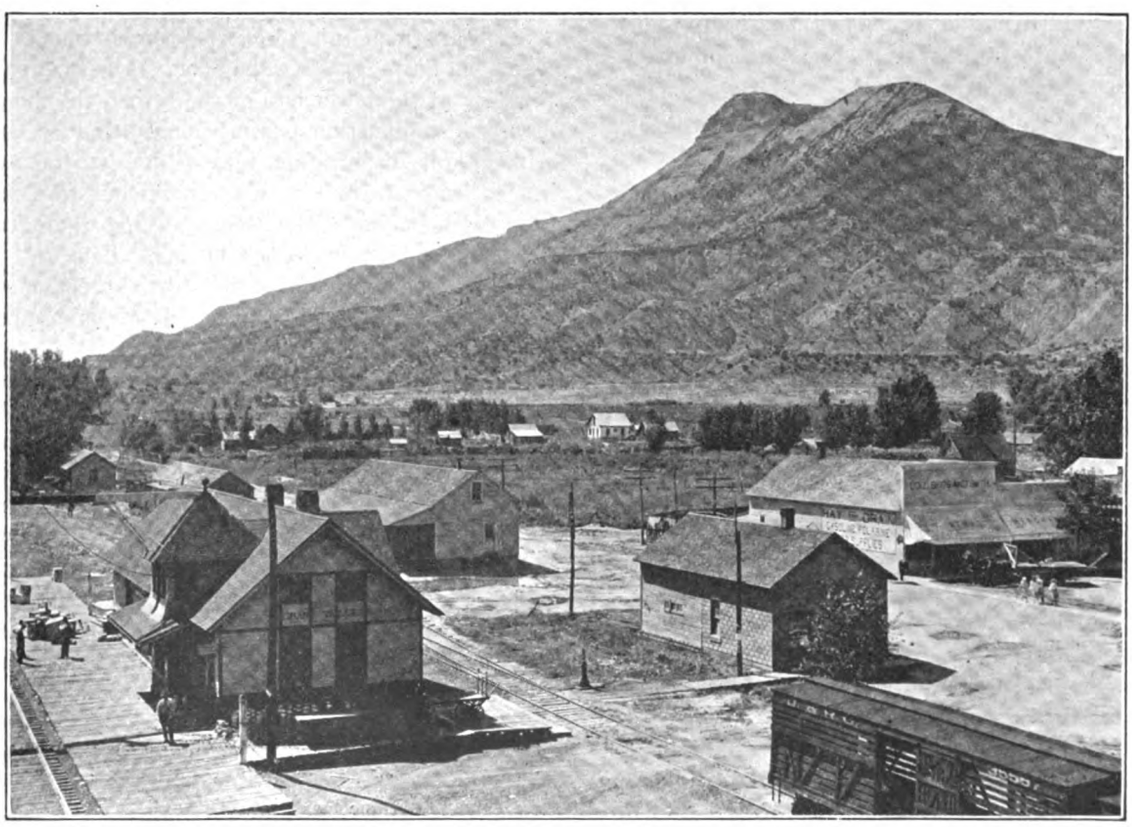


A MOUNTAIN OF OIL-SHALE NEAR DE BEQUE, COLORADO



MT. CALLAHAN, GRAND VALLEY, COLORADO

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shale. On the other hand there are those who question whether any foreign method will suffice. Anyone who has performed experiments with massive oil-shale in a closed retort will have observed the persistent tendency to caking. Some authorities are emphatic in asserting that this shale will not cake if it be heated gradually, while others claim that the admission of steam to the retort during distillation will prevent caking. It is about this very point that the entire controversy over the treatment of our American oil-shale revolves. If we accept a statement quoted from the memoirs of the Geological Survey of Scotland, to the effect that true oil-shale does not cake when heated to redness in a closed vessel, we may conclude that the Scottish shale must differ from the American shale in this significant particular.

Among the advocates of the non-caking theory are the companies that propose to install a retorting process devised by Otto Stahlman of Salt Lake City. The refining of the crude petroleum from these retorts will be done by the Wells process, developed in the Oklahoma oil-fields. The Pearse Engineering Co. of New York controls rights to a modified Scottish process that is being adapted to the Rocky Mountain shales. In its principle of operation it differs little from the foreign methods.

The main feature of all the Scottish retorts is a vertical and rather slender furnace, oblong or cylindrical in cross-section, flaring slightly downward and operated without admission of air. The upper or distillation half of each retort is constructed of steel and is heated from without, the volatile products discharging together into large pipes leading from the top to condensers. The lower portion of each retort is of brick; within this chamber the fixed carbon is burned, in the presence of steam, to generate illuminating gas and ammonia, these products representing the main revenues from the Scotch industry. The shale is fed and discharged continuously or nearly so. The retorts are arranged in batteries or 'benches' of 64 to 80 units. The petroleum, collected as a single product from the condensers, is piped into the refining departments for fractionation. Such plants are expensive, one unit of the Pumpherston retort, including its condenser, ammonia scrubber, and tanks, costing approximately $1700, and having a capacity of only four to five tons of shale per day. This cost does not include the refining. The refining plants are of the type found in petroleum districts.

L. F. Chew of Denver is experimenting with an apparatus that is a modification of a simple gas-producer. In his process, the crushed shale is fed continuously at the top of a vertical brick-lined steel retort. Heat is furnished by the combustion of the fixed carbon of the shale itself at the bottom of the furnace. The spent shale discharges continuously through a shaking grate. It is light in color in contrast with the residual shale drawn from retorts that do not consume the fixed carbon. In practically every other American process only the volatile matter is removed during distillation. In the method just described the incandescent zone extends upward from the grate about 18 inches. The volatile matter is drawn off at the top by suction and is collected as one product.

A Denver company has built a large distillation unit patterned after a McDougall roaster familiar to copper metallurgists. This machine has four distillation chambers containing revolving rakes, each compartment lying above another compartment within which heat is generated by the burning of hydrocarbon vapors injected through burners at one side, the gases of combustion escaping at the opposite side. Crushed shale passes across the decks in alternating radial directions precisely as in an ore-roaster. It is planned to derive different volatile products from each of the four distillation chambers, the temperature of the shale being raised successively at each stage. This process was developed by Messrs. Fefelle and Wingett.

Among the processes originating in Denver is one bearing the name of its inventor, J. H. Galloupe. The shale, after being crushed to one-quarter inch, is fed continuously into the upper end of an inclined (30°) steel retort through which it travels at a rate that will cause the spent shale to discharge at the lower end in about six minutes. The retort is 24 ft. long and 4 ft. wide, and has a rated capacity of 50 tons per 24 hours. In cross-section the bottom side of the retort appears as the arc of a circle struck from the centre of a longitudinal oscillating shaft placed near the top of the retort, which, in cross-section, is an inverted V. Numerous scraper-arms protrude from this shaft. As the shaft moves slowly back and forth, these arms gently but firmly move the thin layer of shale on the floor, causing it to roll or slide forward. The retort is divided, by transverse partitions, into numerous compartments, the partitions not quite reaching the floor. Heat is applied from a fire-box at the lower end of the retort, the flame and hot gases of combustion passing longitudinally beneath the retort and discharging into a flue at the upper end. Pipes lead off from each compartment to separate condensing-members. The accompanying photograph shows that the cooling was done by air. This unit had a capacity of only 15 tons daily, but the commercial units will, as said, handle 100 tons. No air is admitted to the retort.

Numerous other processes are coming into notice, but, so far as I am able to ascertain, they are either unimportant modifications of the Scotch methods or they do not possess sufficient merit to warrant critical investigation. The only process that thus far has been installed in the Colorado shale-field—as previously mentioned—is an adaptation of the Henderson. A 12-ton unit was built by Messrs. Richards and Flynn upon property about 25 miles north-west of De Beque and was operated successfully last summer and fall upon paper shale.

It will be noted that some processes simply distill the hydrocarbons from the shale as a single product that must subsequently be subjected to re-distillation just as is done with petroleum from wells. Other processes perform the initial distillation and fractionation in one stage. I have been told that there has never been one of

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these that succeeded, although there have been many attempts in this direction.

FRACTIONATION. The crude oil derived from shale may be fractionated into numberless products. Most of the companies propose to make only a few shipping products, such as gasoline, kerosene, lubricating oil, wax, and residuum. The operators who install the simple distillation methods will rely upon marketing the crude, or they must erect complete refineries in conjunction with their retorting plants. If the majority of the companies proceed upon the plan of manufacturing only crude oil, it would seem that a splendid opening is afforded for the establishment of custom refineries.

Transportation of the liquid products from the retorting-plants to the railroads will probably be done by motor-trucks with large tanks. Pipe-lines for the delivery of the gasoline and kerosene would be feasible, since all the shale-plants will be at altitudes higher than the railroads. Crude oil and residuum cannot be thus transported for the reason that they are too heavily charged with paraffine, which would freeze in the pipe.

HYDROCARBON PRODUCTS. A good idea as to the petroleum contents of the shale may be obtained by reading Bulletin 641-F, already mentioned. Many individuals and companies have had tests made by professional chemists, and these tally with the results reported by the Government experts.

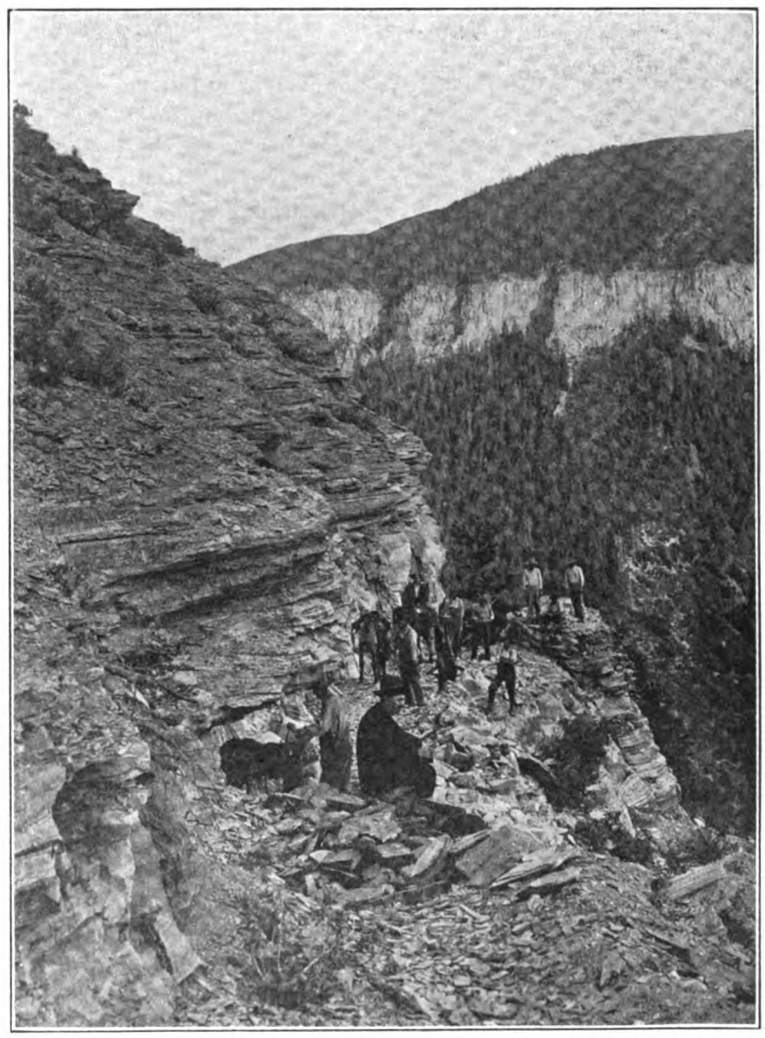
A run made by a prominent Denver chemist upon shale taken about 12 miles north of De Beque showed a total oil content of 46 gallons per ton, the specific gravity being 0.91, equivalent to 24°B. It is proper to remark that it has become the custom to rate oil-shales by the number of gallons of crude oil derived from one ton. Shale of the grade just cited will yield about 17½% crude oil. Upon fractional distillation, the 'crude' from this sample yielded 13.1% gasoline, 45°B., to 150°C.; 38.1% kerosene, 35°B., to 300°C.; and 47.5% residuum, 16°B., to 400°C.

A test made by a refining company in Kansas showed 48 gal. crude per ton of shale, 31.8° B., to 360° C. In re-distillation of this crude, the following was obtained: 15% benzine, 55°B., to 102°C; 10% distillate, 41.7°B., to 132°C.; 20% gas-oil, 34°B., to 194°C.; 25% heavy oil, 25.8°B., to 260°C.; 28% residuum, 18.6°B., to 360°C. This report showed the crude to contain 18.6% heavy wax or grease-stock and 25.8% wax-distillate.

An investigator at Salt Lake City tested a large sample of De Beque shale and reported a recovery of 54.25 gal. per ton. The average temperature of the charge was 525°C. The crude, upon fractionation, yielded 1.5% naphtha to 150°C.; 5% light oil to 200°C.; 16% heavy oil to 250°C.; 16% fuel-oil to 300°C.; the remainder being lubricating oil to 350°C. A laboratory in Kansas City has made many tests and sums up its findings by stating that the average shale will yield, per ton, 5 gal. gasoline, 25 gal. kerosene, 2 lb. benzol, ½ lb. cresol, 100 lb. ammonium sulphate, ¼ lb. phenol, and 10 lb. wax.

A sample of shale-oil sent to an Oklahoma refinery, upon fractionation, yielded 15% gasoline; 16% naphtha, benzine, and kerosene; 43% lubricating oil; and 10% paraffine.

From such returns we observe that the shale is variable



MINING OIL-SHALE NEAR GRAND VALLEY, COLORADO

both in total contents and in the fractions that may be made. Of course, it is not strictly proper to compare these various results, for the reason that the shales and the crude oils were probably handled quite differently by the several chemists. Differing manners of applying the heat during retorting will produce varying results from the same shale, while the splitting of the fractions at different temperatures will likewise make wide variations in the quantities of the several products. Here is a new field for the petroleum technologist.

PROSPECTIVE DEVELOPMENT. There will be great activity this year in the development and equipment of oil-shale properties, but it is improbable that more than a

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few enterprises will get under way on a commercial scale. This is not said in a pessimistic spirit, by any means, but because I appreciate the difficulties confronting every operator in this new industry. Since nobody thus far has operated upon a practical scale in America, we lack knowledge regarding the best methods of procedure in mining as well as in retorting. We have no standard processes generally acceptable. If all managers could feel certain that foreign methods would prove efficient, progress would be rapid. The very fact that so many persons are bringing out processes differing from the Scotch is indicative that there will be considerable experimentation. Several companies are arranging to erect working units based upon new inventions. It is unlikely that all these schemes will prove successful and therefore one may anticipate that some disappointments will be experienced by the pioneers. Men who are in the lead to the extent of risking capital deserve the highest respect from their fellows and followers. Somebody must make the start. Every one of the new schemes has been tested upon a small scale, but, as any engineer knows, this is no assurance that it will prove successful upon a commercial scale. The net result of this year's efforts will be progress in the industry. Mistakes made this year will be of incalculable benefit in guiding further advance.

Cost of Equipment. When it comes to the expense of equipment, we are compelled to guess. The first cost varies tremendously. Some of the proposed schemes call for ten times as much capital as others. Any manager is willing to pay the highest figure if thereby he can feel assured of the best apparatus and the most profitable result. It may be stated roughly that the initial cost of a 100-ton retort and refinery, including the requisite mining, crushing, grinding, and condensing equipment, will be anywhere from $50,000 to $500,000. Before one can offer estimates of cost, there should be some decision as to the proper size of such a plant. Figures have been quoted publicly for plants of a capacity of 1000 tons per day. Such a capacity is perhaps the ideal to which the companies should strive, but, in an industry as new as this, it would seem improper to build a plant to treat 1000 tons daily until we know more about the operation of the processes involved. It is advisable to make the first equipment upon a modest scale, say, of only 100 tons daily in the retorting department, with provision for expansion just as soon as we know how to adjust and operate the selected processes. The crushing and grinding department of a plant can be designed at the start to handle the proposed ultimate tonnage, which may be 1000 tons or 500 tons. Several companies have made plans for plants of 500 tons daily capacity. They propose to put in retorting units to handle only 100 tons per day and to experiment with these until the managers have learned how to operate them perfectly, when additional units can be added to bring the capacity to the 500 tons. Naturally, the cost of handling shale upon a 100-ton basis will considerably exceed the cost per ton when the ultimate capacity is attained. However, the greater operating expense will be warranted if it prevent large losses due to the premature erection of unsuccessful plants.

The equipment for mining or quarrying, at the start, will be cheap. As already explained, the shale-beds, in most instances, outcrop high above the foot of the cliff where retorting plants would logically be erected, and the formation lies almost flat. In most cases, the excavation of the 'ore' can proceed for a considerable time in open workings along the precipitous slope. Eventually, it will be necessary to drive into the hills and to secure the shale by underground methods, probably by a modification of the room-and-pillar system common in coal mining. There are a few properties in which the overburden may be stripped and the shale mined continuously by open methods. In this kind of mining there will be no hoisting or pumping. Ventilation underground will require machinery as the workings are extended. This kind of ground will drill easily by hand, but the cost can be lessened by using machines. Power for driving fans and compressors will be generated by internal-combustion engines utilizing 'home-made' fuel.

One thing that gives considerable concern to each prospective operator is the problem of getting the raw shale from the mine to the plant to be erected at the foot of the cliff. Aerial tramways are planned by two companies. Others believe they will succeed in dropping the broken shale down the steep walls of the gulches in such fashion as to render it readily recoverable by shoveling and tramming.

Costs of Operation. From the foregoing it is apparent that an estimate of the average operating cost will not be possible until a decision is reached concerning the scale of retorting, the method of excavation, the manner of lowering the shale from the mine to the plant, the processes used in distillation and refining, the number of shipping products manufactured, and the scheme for delivering these products to the railroad.

Machinery for crushing and grinding will vary, some processes requiring relatively fine grinding while others call for coarse crushing only. In some of the Scottish methods the shale is crushed only to 6-inch size, whereas in at least one American process it must be reduced to quarter-inch. Oil-shale behaves differently from ordinary shale in crushers and pulverizers, being much tougher and having a tendency to clog the machinery. All kinds of comminuting apparatus are being tested, so that it is impossible to arrive at even rough averages for the probable cost of crushing. This item of expense may vary from 7 to 35c. per ton.

There is more assurance regarding the probable cost of mining. Estimates based upon an initial output of 100 tons per 8-hour day place the cost of securing the shale from outcropping ledges at from 40 to 50c. per ton, these figures including the breaking of the rock and lowering it to the refinery-sites. When the shale is mined underground the cost may be 20c. higher per ton.

The cost of distillation has been estimated between 12 and 65c. per ton; that of condensation depends upon the number of products made and may run from 9 to 17c.

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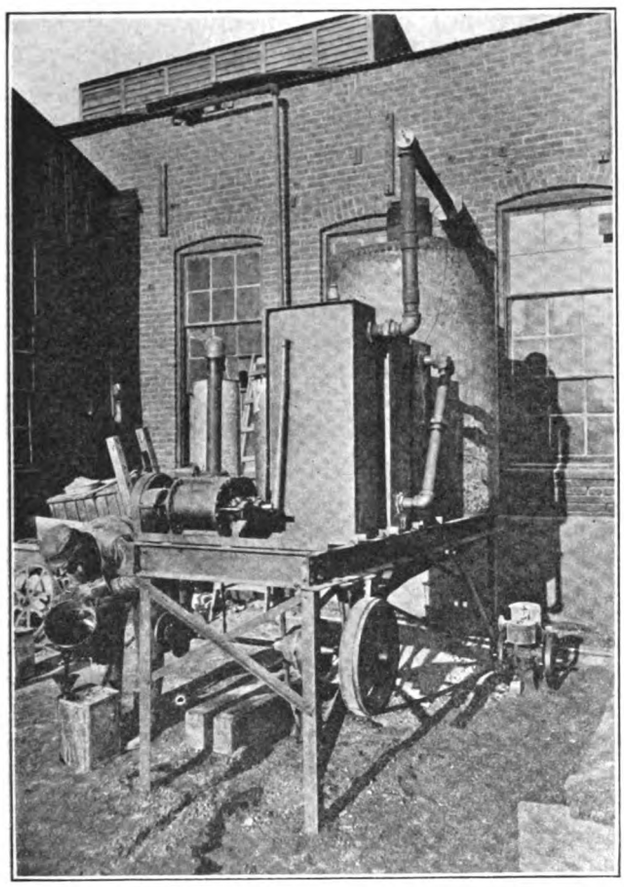
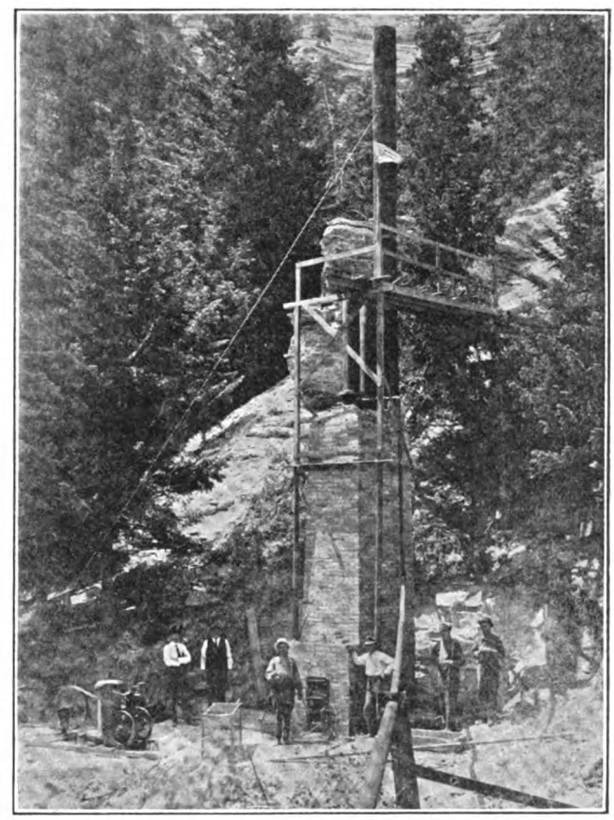
per ton of shale treated. In processes employing separate retorting and refining plants, the item of refining is important, for it may run from 25c. to $1. If by-products or materials other than ordinary gasoline, kerosene, lubricating oils, greases, and wax are to be manufactured, one must allow additional expense for the apparatus and chemicals required.

The cost of fuel will differ according to the process. One company expects to mine an extra ton of shale to be burned on grates in driving off volatile matter from four tons of the same shale. Others intend to conserve the fixed gases that come off first from the shale during distillation and to burn these in the fire-box. If the gases do not supply sufficient heat, they will be augmented by raw shale or possibly by coal or wood. Another suggestion is to manufacture water-gas from the residual carbon in the hot spent shale from the retorts, this gas to be mixed with the non-condensible gases coming from the retorts. In practically every instance, the operator plans to get his fuel from the shale itself.



THE CHEW APPARATUS



THE FLYNN & RICHARDS RETORT

By-products. In Scotland the quantity of crude oil retorted seldom exceeds 30 gal. per ton of shale, and it is a regular practice to treat rock yielding as little as 10 to 15 gallons. In our American shale-field nobody expects to handle shale running below 30 gal., at least for some years to come. An average grade for the shale deposits upon which activities are based in the near future would be one barrel, or 42 gal., per ton. In Scotland the yield of ammonium sulphate constitutes an important factor in the profit. It is said that where the yield of oil is low that of ammonia is high. The nitrogen content is therefore of more significance in Scottish works than the kerogen. To the American way of thinking, it appears that the Scottish profit is dependent largely upon the by-product from the oil-recovery.

American oil-shales invariably yield ammonia upon distillation, and it is probable that every company will contrive to make a commercial product from this variable chemical. Various investigators have reported other by-products, such as potash, gold, silver, and even platinum, in addition to such things as phenol, benzol, cresol, ozokerite, and dye-stuffs. Some of these substances may be recovered from the shale at a profit under prevailing market-prices, but there is doubt regarding the commercial outlook after the War. The spent shale will average 1% K_2O, too little to warrant the necessary expenditure for recovering potash, even at current prices. As to the precious metals, I am skeptical and suggest that samples have been salted unintentionally in the laboratories. A few cents per ton of shale handled might be received from the sale of benzol, cresol, and phenol, but the profit might prove a negative quantity. If it really prove possible to manufacture 10 lb. of ozokerite per ton of shale, as one chemist claims, this single item would offer greater returns than all the other products combined.

In the domestic industry, plans are laid primarily to make but a few primary products, such as motor-spirit, fuel-oil, lubricating oil, and residuum, for all of which

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there will continue a steady demand indefinitely. Managers will, no doubt, be awake to the potentialities in by-products and will, in the course of time, make preparations to manufacture such of them as offer a profit.

PROPERTY RIGHTS. It is necessary to make some mention of the legislative troubles confronting future locators of oil-shale land. Up to the present, this kind of land has been located under the ordinary oil-placer regulations, claims being usually of 160 acres each, in the names of eight persons. Bills are pending in Congress looking to future restrictions in the location of all kinds of oil-yielding land. It is likely that Congress will place all non-located oil-shale land in the same general class with ordinary petroleum land, so that future locations will be governed by the same regulations as to acreage and lease royalties as will apply to oil-lands.

A MANUFACTURING INDUSTRY. The operation of an oil-shale plant is a manufacturing proposition. The supply of raw material is abundant and plants can be designed for long service. There is little or no speculation regarding the grade of the raw material because the beds continue reasonably uniform in their content of kerogen over considerable distances. The markets for the products will remain strong for years to come. The supply of motor-fuels, derived from petroleum wells, has been falling steadily behind the needs of the world at large. The uncertainties confronting this industry are primarily in the selection of suitable schemes of treatment, but these will be settled before long by those that have the nerve to make the first moves in the erection of commercial plants.

There is one feature of this business that has not been sufficiently recognized. This is the necessity of placing the technical and practical affairs of the business in the hands of men properly qualified. The remark is often made that we have, in America, too few experts in this line, and this is literally true. At the same time, we have plenty of engineers that have had sufficient experience in branches not widely different from this new business to have given them the foresight and judgment needed for avoiding serious blunders. It is stupid to risk capital in projects that are to be managed by laymen who assume they are capable of handling this business at least as well as a trained engineer. Even with the best available technical advice, companies may experience difficulties at first, but such troubles will be vastly less costly than those to be faced by shortsighted operators unwilling to employ engineers. On the other hand, investors must be on their guard against numerous shysters that pose as experts. The activities of such persons are apparent already.

PROPOSED STANDARDIZATION OF SCREW-THREADS

A bill has been reported favorably to the House of Representatives providing for the appointment of a commission to standardize within one year screw-threads of all kinds, the resultant standards to be promulgated by the Secretary of Commerce for use by the Government and by private manufacturers. The commission is to be composed of the director of the Bureau of Standards, who shall act as chairman, one commissioned officer of the Army and one of the Navy, the remaining two members to be chosen by the Secretary of Commerce, one from nominations made by the American Society of Mechanical Engineers and one from nominations by the Society of Automotive Engineers. In the discussions before the Committee on Weights and Measures, attention was called to the delay and inconvenience in the munitions program that had already occurred as a result of the present lack of standardization, particularly with reference to tolerances. Several thousand dollars worth of gauges have had to be scrapped. F. O. Wells, president of the Greenfield Tap & Die Corporation, of Greenfield, Massachusetts, went so far as to say:

"Army and Navy officials of high rank have agreed with me that if this thing had been done before the War, ten years before, if the French, the English, and the Americans, all the Allies, had had one standard of tolerance so that they could have interchanged their blueprints, their jigs, and their gauges, we would never have had a war. They all agreed with me that Germany would never then have dared to tackle us."

WEAR ON CONCRETE PAVEMENT IN HARTFORD, CONNECTICUT*

By LEON F. PECK

In September 1913 the first concrete pavement in Hartford was laid on Capitol avenue between Main street and Whitman court. Traffic averaged in 1916 about 600 horse-drawn vehicles and 700 automobiles per 12-hour day. The average width between the curbs was 26 ft. The concrete was composed of one part portland cement, two parts Connecticut River sand, and four parts crushed trap-rock. The concrete was machine-mived and cured by frequent sprinklings. No covering was used. Wear was determined by readings on the top of copper dowels cemented in the bottom of nine test-holes about 2½ in. square and 3 in. deep. The readings on the surface of the pavement were taken on a transverse line 6 in. south of each test-hole.

The results are shown in the following table:

	Wear in feet		
	Oct. 24, 1914 to Nov. 23, 1915	Oct. 24, 1914 to Nov. 23, 1915	Oct. 24, 1914 to Nov. 23, 1915
Sta. 0 + 25			
5.5 ft. from south curb.....	0.001	0.003	0.008
12.5 " " " "	0.007	0.021	0.026
19.5 " " " "	0.009	0.021	0.021
Sta. 1 + 33.25			
5.5 ft. from south curb.....	0.006	0.012	0.012
12.5 " " " "	0.003	0.012	0.012
19.5 " " " "	0.015	0.019	0.035
Sta. 2 + 36.5			
5.5 ft. from south curb.....	0.008	0.012	0.015
12.5 " " " "	0.006	0.015	0.022
19.5 " " " "	0.004	0.015	0.022
Average	0.0066	0.0153	0.0206

This is at a rate of about 0.08 in. per year.

*From 'Concrete Highway Magazine.'

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Velocity and Mixing of Oil in Pipe-Lines*

At low temperatures, when the viscosity of the oil is large, the flow is below the so-called 'critical' velocity, or point where turbulence begins. In other words, at these low temperatures the 'flow-curve' is a straight line, the velocity increasing directly with the pressure. As the temperature increases, turbulence begins at lower and lower velocities, and finally, at high temperatures the oil behaves much like water, turbulence commences almost as soon as the liquid starts to move. Two critical velocities exist for a given oil. When the flow is increasing, a rate of speed is reached when the straight-line flow breaks into swirling turbulent flow. On the other hand, when the oil is already moving at a turbulent velocity, and this velocity is gradually reduced, the velocity must be reduced considerably below the point at which turbulence began at increasing velocities before straight-line flow will commence. There is considerable uncertainty regarding the behavior of a given oil at points on the flow-curve between the two critical velocities. For increasing velocities, the straight-line condition will probably extend to the higher critical velocity, but between the lower and the higher critical velocity unstable conditions of flow will prevail. When straight-line flow finally ceases there will be a short period of 'super-turbulence' in which additional pressure produces little or no additional velocity. After this stage is passed the form of the flow-curve approaches a parabola, with the velocity proportional to the square root of the pressure.

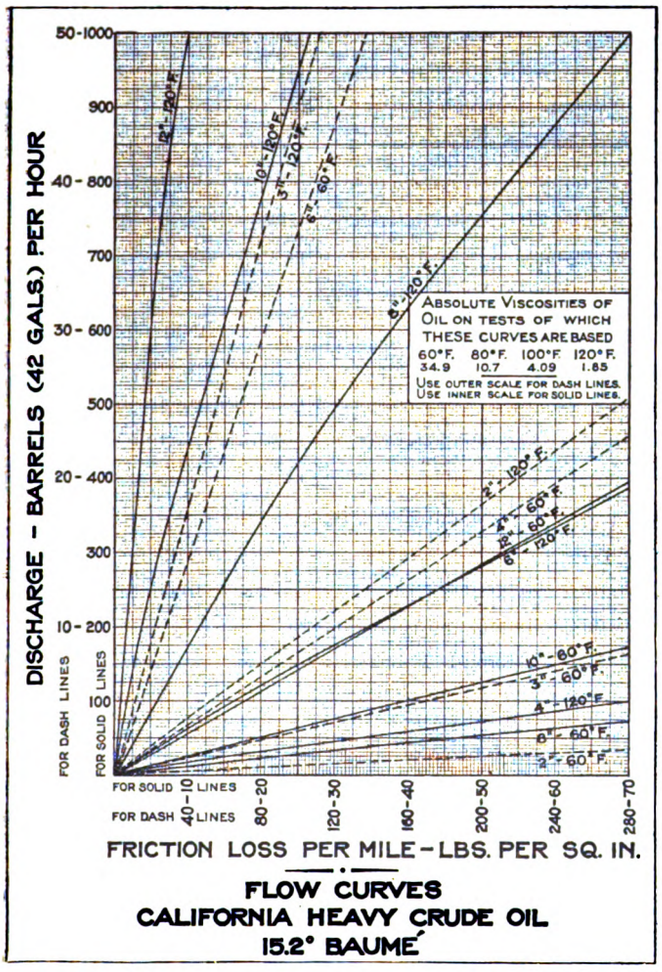

FIG. 2. FLOW-CURVES FOR HEAVY OIL

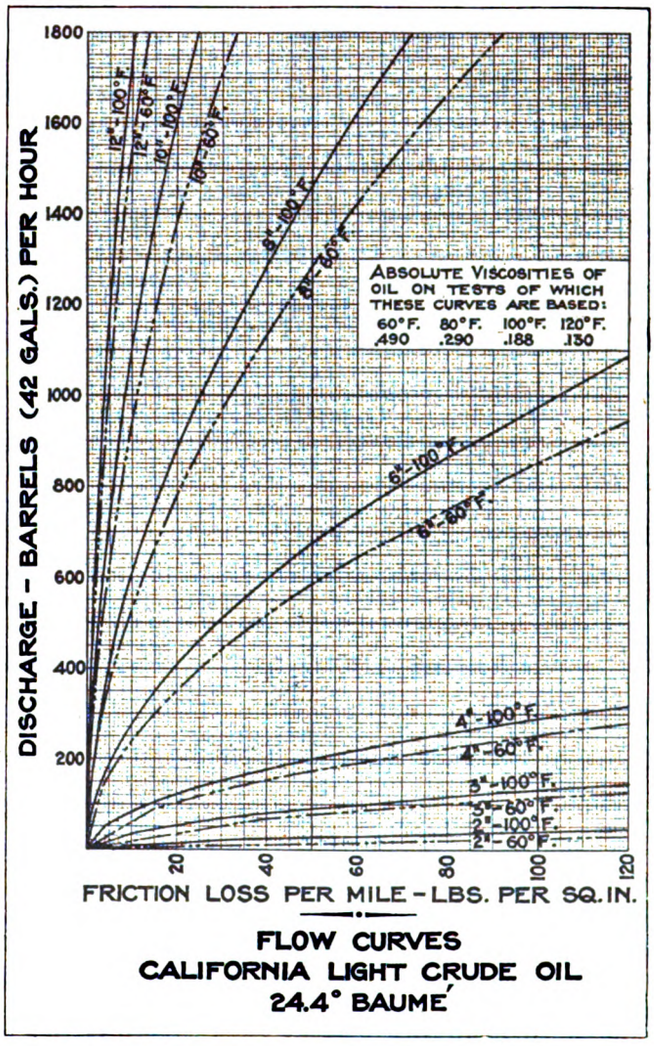

FIG. 1. FLOW-CURVES FOR LIGHT OIL

Fig. 1 shows flow-curves for a typical Californian light-gravity oil for various sizes of pipe and for temperatures of 60°F. and 100°F. These temperatures have been used because in practice the oil is either not heated at all, in which case its temperature may be assumed to be approximately 60°F., or else is heated to such a temperature that its average temperature when flowing is

*Abstract from 'Standard Oil Bulletin.'

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about 100°F. Fig. 2 shows similar curves for a heavy-gravity oil. A temperature of 120° is used instead of 100°F. because the heavy oils are usually brought to a higher temperature when pumping.

In determining the average temperature of the oil when flowing, several factors must be considered. In the first place the oil will cool more rapidly after it has been heated than later, when its temperature is nearer to that of the ground surrounding the pipe-line. Secondly, resistance to flow increases rapidly as the temperature decreases. The following approximate formula may be used:

Average temperature $= \frac{1}{3}T + \frac{2}{3}t$,
where T = initial temperature;
t = final temperature.

While the curves shown are for 24.4 and 15.2 gravity oils, respectively, they may be used for computations for other oils whose absolute viscosity is known. For instance, assume an 18 gravity oil with an absolute viscosity of 1.75 at the average temperature when flowing. From Fig. 2, 15.2 gravity oil has a viscosity of 1.75 at a temperature of approximately 121°F. Consequently, the 18 gravity oil at the given temperature will act like 15.2 gravity oil at a temperature of 121°F.

This principle of equivalent viscosities is strictly accurate only for estimating flow below the critical velocity, at which points viscosity offers practically the only resistance. However, it is sufficiently accurate for all practical purposes for any speeds, since experience has shown that even above the critical velocity, oils that have the same velocity and somewhere near the same gravity, offer approximately the same resistance to flow.

Whenever one kind of oil is pumped behind another kind in a pipe-line, a certain amount of mixing is sure to take place. The principal reason for this is the fact that when any oil flows through a pipe, the particles near the centre flow faster than those near the sides. If the average rate is below the critical velocity, so that the flow is straight-line in character, the velocity near the walls of the pipe may be one-third less than at the centre. If the velocity is high and the viscosity low, so that considerable turbulence exists, the velocity near the walls will probably be at least 90% of the velocity at the centre. Turbulence and the force of gravity both tend to reduce somewhat the amount that the oil in the centre gains on the oil at the sides and consequently reduce the amount of mixing between two oils.

Operating conditions on a long line with several pumping stations also affect the amount of mixing that occurs between two oils being pumped through the same line. In order to provide for differences in speed of the pumps and for other irregularities of operation, 'equalizing tanks' are provided at each station. Assume for instance a line with two intermediate stations A and B, and that a light oil is being pumped behind a heavy one. The pumps at stations A and B are both connected to the heavy-oil equalizing tanks and the pumps at station B are running faster than those at station A and are withdrawing oil from the tank. When the light oil begins to arrive at station B, the operator will be waiting to switch from his heavy-oil to his light-oil tank. Some time, however, is required to take the gravity of enough samples to make sure that the proper point to 'cut' between the two oils has arrived and also to change the connections. During all this time heavy oil has been drawn from the equalizing tank and mixed with any light oil that is passing through the line. This makes the line between the light and heavy oils still harder to determine at any point beyond station B, and the operator at station C will find it still more difficult to determine when to switch tanks. The result is a cumulative increase in the amount of mixing as the oil reaches the receiving-end. A test made recently at the receiving-end of one of the Standard Oil Co.'s trunk lines with 22 gravity oil following 15 gravity oil showed that the mixture of the two oils took 5 hours and 20 minutes to pass. As the rate of pumping was 1256 bbl. per hour, the amount of the mixture was nearly 7000 barrels.

In order to reduce the number of times that this unavoidable mixing takes place, the field oil is segregated into groups. Oils whose refining characteristics are similar are stored until a large quantity, 100,000 bbl. or more, is ready for shipment. Furthermore, shipments of different kinds of oil are arranged so that the resulting mixtures will offer the least difficulty to the refining department. In addition, care is taken in determining the point to 'cut' the delivery between a light and a heavy oil. If the two oils happen to have similar refining characteristics, the 'cut' is usually made at the point where the two oils are mixed about evenly. If, however, a light oil that is used for special purposes is being pumped behind a heavy oil that contains ingredients that would be harmful in refining the light oil, the 'cut' cannot be made until practically the last trace of heavy oil has disappeared. Sometimes two oils are pumped through the line, each having characteristics that would be harmful to the other oil. In such cases, a 'buffer batch,' usually about 5000 bbl., of some oil that will not be harmful to either of the first two oils is run between them.

In planning shipments through a pipe-line, attention should be paid to the probable effect on the temperature of the pipe itself. Heavy oil is heated before pumping to reduce its viscosity. On the other hand, light oil is frequently pumped cold to prevent volatilization of the lighter constituents. If a cold light oil follows immediately after a heated heavy oil the pipe contracts, and there is danger of the resulting stresses causing failure or at least leakage at some of the joints. Care must therefore be taken to arrange shipments so that sudden changes of temperature do not occur.

The proved oil-bearing area in California, according to the 'Standard Oil Bulletin,' is 88,745 acres, or 138.66 square miles. In the computations, the boundary-lines of the proved area were drawn 200 to 300 ft. outside producing wells. For outlying wells the field is credited with 15 acres per well. The total production to December 31, 1917, was 1,040,350,614 barrels.

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Effect of Certain Substances on the Strength and Setting-Time of Cement and Concrete

In a recent number of the 'Philippine Journal of Science', J. C. Witt discusses the effect of certain electrolytes upon cement and concrete. A bibliography is given of articles dealing with investigations of the effects of one or more of these substances, together with a summary of the results observed in each investigation. The incompleteness of the data available is noticeable. Except for some substances, such as calcium sulphate, that have been investigated in great detail by a number of workers, little definite information is available. Some electrolytes have been studied by only one investigator. Most of the articles published do not cover sufficient ground to make the work of general value. This is true of boric acid, barium chloride, calcium oxychloride, calcium thiosulphate, and lithium chloride. Frequently, when a substance has been investigated by a number of persons, conflicting results are obtained. According to Chandlot and Rohland, sodium chloride has no effect on cement, but Dobrzynski and Passow say that it increases the tensile strength. Rohland classes sodium carbonate as an accelerator of the set of cement, while in a previous paper he stated that it might either retard or accelerate it. Similar disagreements on the effect of calcium chloride may be found, though its general effect on the set has been established. One interesting example of disagreement is that of ferrous compounds. Desch is of the opinion that if ferrous iron is present in cement it may be converted into ferrous sulphide by calcium sulphide, which is produced by the reducing action of the fuel. Ferrous sulphide is considered objectionable because of its ability to become oxidized, which would result in a change in volume. However, there is a French patent for the right to add from 1 to 3% dry ferrous sulphate to cement. It is claimed that this will accelerate the set and increase the strength. The general effect of calcium sulphate is perhaps better known than that of any other substance, because so much research has resulted from its use in the manufacture of cement. However, there are still many conflicting views on the part played by this substance in controlling the set and the amount that can be added without endangering the quality.

The causes that have thus far prevented many of the investigations carried on by various workers from being comparable may be divided into two classes:

1. Details that either cannot be controlled by the investigator or which can be controlled only with considerable difficulty. These include the individual characteristics of cements, resulting from the composition of the raw materials and the methods of manufacture; the personal equation of the investigator; variations in temperature and humidity because of change of season and of location; and difference in apparatus and method of procedure in various countries. Most of these points do not require explanation. Cements of the same chemical analysis may be entirely different in their physical properties. While it would be possible to control the temperature and humidity of laboratories so that cement could always be tested under the same conditions, the time and expense would be hardly justified.

2. Details that can be controlled easily by the investigator. These include the adoption of some definite plan for the work, so that results obtained with different substances may be directly comparable in so far as the concentration and purity of the solutions employed are concerned; analysis and physical tests of all cements as received; the choice of a sufficient number of cements so that results may be considered as averages.

Chemical and physical tests of all cements investigated should be made because the results may point out the constituent of the cement that is most concerned in the observed results. The conditions under which work is done, including the average temperature, humidity, and laboratory methods, should be given because they are of recognized importance. As a rule, solutions are made on the percentage basis and are not afterward analyzed. The results obtained are not directly comparable in some respects. For instance, it usually happens that no account is taken of atomic weights and valencies. An investigator may make solutions of aluminum chloride and sodium chloride and compare results obtained by the same percentage concentrations of each, although aluminum chloride contains a much higher percentage of chlorine than does sodium chloride. Likewise in comparing the relative effects of calcium chloride and calcium sulphate the percentage basis is not the proper one.

Little progress can be made in this field of investigation until the results of various workers can be connected by certain generalizations. The most important points are:

1. Does the effect of an electrolyte depend on the negative ion, the positive ion, or on both?

2. Is the degree of solubility of the corresponding calcium salt important?

3. Can the effect of an untried electrolyte be predicted from results obtained with others?

4. Can the observed effect be traced to any particular constituent of the cement?

When No. 1 and 2 have been determined for a large number of electrolytes, it should be possible to predict the effect of an untried electrolyte—at least qualitatively—on many cements. No. 4 is of great practical importance. Such data could be used as factors in determining the cement best suited for construction that is to be exposed

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to certain conditions. This has already been done in the study of the effect of sea-water on cement. It has been shown for some cements that the iron content is one of the factors which determines the effect of sodium sulphide.

This paper presents the results of experiments that have been undertaken in an effort to correlate investigations in this field of research. Two barrels each of four brands of cement were chosen. Each barrel was carefully sampled, and the cement was then preserved in suitable containers during the progress of the work. The results of the chemical analysis and the physical tests of the cements as received in the laboratory are given in Tables I and II.

Table I. Chemical Analysis of Cements, %

	I	II	III	IV
Loss on ignition	2.43	2.15	2.17	3.24
Silica (SiO_2)	22.60	21.40	21.26	20.62
Alumina (Al_2O_3)	7.72	7.58	8.54	6.62
Ferric oxide (Fe_2O_3)	1.76	1.70	2.08	2.56
Calcium oxide (CaO)	61.32	62.94	62.82	63.50
Magnesia (MgO)	1.08	1.37	1.13	1.43
Sulphuric anhydride (SO_3)	1.45	1.61	1.02	0.82
Sodium and potassium oxides (Na_2O, K_2O)	1.63	1.14	1.17	1.33

Table II. Physical Tests of Cements as Received

	Fineness			Initial set		Final set		Tensile strength in pounds per sq. in.		
Brand	200-mesh	100-mesh	Specific gravity	Hr.	Min.	Hr.	Min.	7 days	28 days	180 days
I	81.1	97.0	3.12	4	5	6	48	267	359	365
II	83.7	97.0	3.10	3	56	5	44	280	351	373
III	85.7	98.2	3.12	3	36	6	12	321	389	413
IV	83.7	89.4	3.10	3	46	6	47	218	297	373

The following electrolytes were chosen:

Sodium chloride.	Sodium sulphate
Zinc chloride	Zinc sulphate
Copper chloride	Copper sulphate
Sodium nitrate	Sodium bicarbonate
Potassium nitrate	Potassium bicarbonate
Ammonium nitrate	

If a cement is gauged with solutions of several chlorides, containing the same amount of chlorine per litre, it should give the same results, aside from the experimental error, as far as the chlorine ion is concerned. In the same way, if we gauge a cement with solutions of several salts of sodium, for example, having the same amount of sodium per litre, we have a basis for comparing the effect of the negative ion. Further, by using a number of salts that form soluble calcium compounds and a number of others that produce difficultly soluble calcium compounds, we should be able to obtain data on the question of whether or not there is any relation between the effect of electrolytes and the solubility of the calcium compounds which they produce.

A stock solution of each electrolyte was first made and standardized. This was normal on the basis of the negative ion. Various dilutions were then made as needed. Care was taken to choose no electrolyte that contained the principal metallic elements found in cement, such as calcium and aluminum, or any that contained metals that might act in the same way, such as iron and magnesium. The data on all solutions employed are given in Table III.

Mortar briquettes were made from each cement, using water and four concentrations of each of the eleven solutions mentioned; also setting-time* and soundness tests were made on each cement with each solution. The approximate average temperature was 30° C., and the average relative humidity was about 80%. All the tests were made in accordance with U. S. Government specifications for portland cement.† The normal consistence of each cement was determined with the various solutions.

The general tendency of all the solutions is to decrease the tensile strength. Of the 352 results here recorded (which represent 1056 briquettes), only 44 show an increase in strength, and as a rule, this increase is small. The greatest number of such cases occurs with the sulphates. The increases occur mostly with cements No. I and II and with the 1.0 and the 0.5 normal solution. The decrease in tensile strength is most prominent with the 7-day briquettes, particularly for the maximum concentration of each solution employed. Cement No. IV is the most sensitive to the effect of the solutions in lowering the tensile strength. With this cement, every solution used

TABLE III. PROPERTIES OF SOLUTIONS USED

Salt.	Normality.	Grams of salt per cubic centimeter (by analysis).	Centimeters of solution required for normal consistency.[a]	Parts by weight per 100 grams of cement. Of salt.	Of positive radical.	Of negative radical.
Sodium chloride	0.05	0.0029	22	0.0640	0.0252	0.0388
	0.10	0.0058	23	0.1339	0.0527	0.0812
	0.50	0.0291	23	0.6695	0.2634	0.4061
	1.00	0.0582	22	1.2810	0.5040	0.7770
Zinc chloride	0.05	0.0034	22	0.0753	0.0361	0.0392
	0.10	0.0068	23	0.1575	0.0756	0.0819
	0.50	0.0342	23	0.7874	0.3779	0.4095
	1.00	0.0685	22	1.5065	0.7226	0.7839
Copper chloride	0.05	0.0034	22	0.0741	0.0351	0.0390
	0.10	0.0067	23	0.1549	0.0732	0.0817
	0.50	0.0337	23	0.7745	0.3663	0.4082
	1.00	0.0674	22	1.4824	0.7011	0.7813
Sodium nitrate	0.05	0.0043	22	0.0937	0.0253	0.0684
	0.10	0.0085	23	0.1959	0.0530	0.1419
	0.50	0.0426	23	0.9795	0.2650	0.7145
	1.00	0.0852	22	1.8739	0.5069	1.3670
Potassium nitrate	0.05	0.0051	22	0.1116	0.0432	0.0684
	0.10	0.0102	23	0.2334	0.0904	0.1430
	0.50	0.0508	23	1.1670	0.4520	0.7150
	1.00	0.1015	22	2.2332	0.8646	1.3686
Ammonium nitrate	0.05	0.0040	22	0.0883	0.0199	0.0684
	0.10	0.0080	23	0.1846	0.0416	0.1430
	0.50	0.0401	23	0.9230	0.2079	0.7151
	1.00	0.0803	22	1.7659	0.3978	1.3681
Sodium sulphate	0.05	0.0036	22	0.0785	0.0254	0.0531
	0.10	0.0071	23	0.1643	0.0532	0.1111
	0.50	0.0357	23	0.8215	0.2661	0.5554
	1.00	0.0714	22	1.5719	0.5091	1.0628
Zinc sulphate	0.05	0.0040	22	0.0886	0.0359	0.0527
	0.10	0.0081	23	0.1852	0.0751	0.1101
	0.50	0.0403	23	0.9260	0.3753	0.5507
	1.00	0.0806	23	1.7721	0.7181	1.0540
Copper sulphate	0.05	0.0040	22	0.0881	0.0351	0.0530
	0.10	0.0080	23	0.1843	0.0734	0.1109
	0.50	0.0401	23	0.9215	0.3672	0.5543
	1.00	0.0801	22	1.7628	0.7025	1.0603
Sodium[b] bicarbonate	0.05	0.0020	22	0.0447	0.0125	0.0316
	0.10	0.0041	23	0.0935	0.0262	0.0661
	0.50	0.0203	22	0.4472	0.1259	0.3163
	1.00	0.0407	22	0.8947	0.2509	0.6327
Potassium[b] bicarbonate	0.05	0.0024	22	0.0538	0.0185	0.0318
	0.10	0.0049	23	0.1126	0.0449	0.0663
	0.50	0.0245	23	0.5629	0.2246	0.3319
	1.00	0.0489	22	1.0769	0.3706	0.6365

[a] The normal consistency values given in this column are averages for the four cements. In nearly every case the variation was only 1 or 2 per cent. In gauging cement IV with 0.50 *N* copper sulphate and with 0.50 *N* potassium bicarbonate, however, the normal consistency was unusually high, being 26 and 28 per cent, respectively. These two values were not counted in the averages given here.

[b] The concentrations of these solutions are based on the amount of CO_3 present. They are only half the indicated concentrations with respect to alkalinity.

*Each cement used in this investigation contains calcium sulphate. Consequently when a cement is gauged with a solution of an electrolyte, the observed setting time may be included in the resultant of the effects of the two substances.

†See Circular 33, U. S. Bureau of Standards, Washington, Government Printing Office (1912).

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causes one or more series of briquettes to fall below the specified limits. This cement is highest in calcium content.

Apparently there is no relation between the effect of the solutions on the set and on the tensile strength. On the basis of their effect on the set, the salts may be divided into two groups:

1. Sodium chloride, sodium nitrate, potassium nitrate, ammonium nitrate, sodium sulphate, sodium bicarbonate, and potassium bicarbonate.

2. Zinc chloride, copper chloride, zinc sulphate, and copper sulphate.

When a member of the first group is added to a cement, a small amount of the salt causes a retardation of the set. After a maximum point is reached, the set is accelerated by further additions of the substance, until the original setting-time is reached or even passed. Within the limits investigated, the behavior of these electrolytes is, in general, similar to many others that have been investigated from time to time, such as sodium sulphide and calcium sulphate. The second group shows a retardation with the lowest concentration of each solution employed. The retardation increases with increasing concentration. For the ranges studied the time-concentration curves of these salts rise indefinitely. This is contrary to the corresponding curves of group No. 1, which pass through maximum points.

Though it was expected that the results would tend to divide the salts into groups, the basis of division indicated by this work was somewhat surprising. This basis is neither the solubility of the resulting calcium compounds nor the negative ion. It is chiefly the positive ion. Both zinc salts and both copper salts show similar effects, whereas the other chlorides and sulphates behave differently. Since calcium sulphate is dissolved with difficulty and calcium chloride is dissolved easily, no division can be made on that basis. With one or two exceptions the substances used in the tests affect all the cements in the same way.

A number of statements appear in the literature which attempt to account for the effect of electrolytes on cements, but usually there can be found as many exceptions as there are instances of agreement. For instance, Dobrzynski found that the normal consistence of cement, when gauged with solutions of certain chlorides, varied with the solubility of the salt. In the present work, cements gauged with sodium, copper, and zinc chlorides, which differ widely in solubility, showed the same normal consistence (Table III). Kallauner is of the opinion that all soluble calcium salts decompose cement. This is not in conformity with other work with calcium salts. Though many believe that the major effect of an electrolyte is the result of the negative ion, especially in so far as this may be able to affect the solubility of the calcium compounds in the cement, the present results do not indicate this. The statement of Rohland in various papers that cement is affected by catalizers positive and negative is not an adequate explanation. There are instances in which the great change in the setting time of cement caused by electrolytes seems to be catalytic, but in most cases the relation between the effect and the amount of the electrolyte present suggests some physical or chemical influence which is not catalysis but which has not as yet been explained.

THE STRENGTH OF BRICK PIERS

A series of tests of the strength of brick piers has recently been made by the U. S. Bureau of Standards, working in co-operation with the technical committee of the National Brick Manufacturers' Association. About 50 piers 2½ ft. square and 10 ft. high, constructed with various kinds of brick and mortar, were used. The following conclusions have been announced:

1. The primary cause of failure of brick piers is transverse failure of the individual bricks.

2. The ultimate strength of the pier may be increased by any method of construction that will increase the depth of the component parts of the pier. This may be done by laying the bricks on edge instead of flat, by breaking joints every few courses instead of every course, or by using bricks of more than ordinary thickness.

3. The strength of the pier may be increased by the introduction of wire mesh in all horizontal joints. The increase is slight, however, unless the mesh is used in every joint.

4. Varying the number of header-courses used does not appreciably affect the ultimate strength of the pier.

5. The mortar joints should be made as thin as possible. They should be of uniform thickness. For this reason regularity in shape of the bricks is essential.

6. The ultimate strength of brick piers is proportional to the compressive and transverse strength of the bricks used in their construction.

7. The kind of mortar used affects the strength of brick masonry. A pure lime mortar is inefficient when high compressive strength is desired. In a mortar of 1 part portland cement to 3 parts sand, 25% by volume of the cement may be replaced by hydrated lime without appreciably affecting the strength of brick piers. Larger proportions of lime up to 50% by volume may be used on piers of small cross-sectional dimensions without affecting the strength.

A load-curve of telephone calls for the system of the Pacific Telephone & Telegraph Co. in Los Angeles is shown in the annual report of the Board of Public Utilities of that city. Between midnight and 6 a.m. the number of calls is less than 4000 per hour. The curve rises to a peak between 9 and 10 a.m. of 38,000 calls per hour. There is a slight decrease until the period between noon and 1 p.m., when the number of calls per hour is 28,000. From 1 p.m. the curve is nearly horizontal until it commences to rise to an afternoon peak between 4 and 6 p.m. of 30,000 calls per hour. From this point the decline of the curve is rapid until midnight, when the rate is less than 2000 calls per hour.

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Engineers' Note Book

TABLES FOR DETERMINING SIZES OF WOODEN FORMS FOR CONCRETE*

By J. J. ROSENTHAL†

The following tables give the minimum sizes and maximum spacings of centring posts, girders, and joists, and should prove valuable both as a means of checking and in designing concrete forms. In Table I each slab is given an identifying number which is used as a reference in the other tables in relation to its thickness.

It will be noted that a choice of sizes is given in all the tables, so that the local lumber dealers' supply may be utilized.

TABLE I. SLAB NUMBERS

Slab numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Slab thickness in inches:																	
Solid slab	3	4	..	..	5	..	..	6	..	7	..	8	..	9	10	11	12
Combination tile and concrete	..	6	7	..	..	9	10	11	12	13	14	..	15	..	..	..	..

TABLE II. POSTS FOR CENTRING

3 by 4 in. solid:

To be spaced 4 by 6 ft. or less under slabs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, braced in four directions every 7 ft.

To be spaced 4 by 4 ft. or less under slabs 11, 12, 13, 14, 15, 16, 17, and 4 ft. apart under girders or beams.

4 by 4 in. solid, or T-posts of two 2 by 4 in., properly spiked:

To be spaced 6 by 6 ft, or less under slabs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, braced in four directions every 8 ft.

To be spaced 4 by 6 ft. or less under slabs 11, 12, 13, 14, 15, 16, 17, or 5 ft. apart under girders or beams.

6 by 6 in. solid, or T-post of 2 by 4 in. and 2 by 6 in., properly spiked, braced in four directions every 8 ft.

To be spaced 6 by 6 ft. or less under slabs 12, 13, 14, 15, 16, 17, or 6 ft. apart under girders or beams.

TABLE III

SIZE AND SPACING OF JOISTS ON 4-FT. SPAN

Slab number	Size in.	Spacing in.
1	2 by 4	16
	2 by 4	24
2 to 15, inclusive	2 by 6	24
16	2 by 6	21
17	2 by 6	21

TABLE IV

SIZE AND SPACING OF JOISTS ON 6-FT. SPAN

1, 2	2 by 6	16
	2 by 8	24
1	2 by 6	15
	2 by 8	24
4, 5, 6	2 by 6	14
	2 by 8	24
7, 8	2 by 6	12
	2 by 8	24
9, 10, 11, 12, 13	2 by 6	12
	2 by 8	21
14, 15, 16, 17	2 by 8	21
	2 by 8	18

Flooring over joists may be $\frac{7}{8}$ in. thick (1 in. dressed) on spans less than 21 in. It must be 1 in. ($1\frac{1}{4}$ in. dressed) on spans of 21 and 24 in. Joists should be cross-bridged every four feet.

TABLE V

MINIMUM SIZES OF GIRDERS ACROSS POSTS ON 4-FT. SPAN. SPAN OF JOISTS 4 OR 6 FT.

Slab number	Size, inches
1, 2	2 by 10, 3 by 8, or 4 by 6
3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	2 by 10, or 3 by 8
14	2 by 10, 4 by 8, or 6 by 6
15	3 by 10, 4 by 8, or 6 by 6
16	3 by 10, or 4 by 8
17	2 by 12, 3 by 10, or 4 by 8

TABLE VI

MINIMUM SIZES OF GIRDERS ACROSS POSTS ON 6-FT. SPAN. SPAN OF JOISTS 4 OR 6 FT.

Slab number	Size, inches
1	2 by 12, or 3 by 10
2, 3	3 by 12, 4 by 10, or 6 by 8
4, 5, 6, 7, 8, 9	2 by 14, 3 by 12, 4 by 10, or 6 by 8
10	2 by 14, 3 by 12, 5 by 10, or 6 by 9
11	3 by 12, 6 by 9, or 7 by 8
12, 13	3 by 12, 5 by 10, 6 by 9, or 7 by 8
14	4 by 12, 5 by 10, or 6 by 9
15	3 by 14, 4 by 12, 5 by 10, 6 by 9, or 8 by 8
16	2 by 16, 3 by 14, 4 by 12, 5 by 10, 7 by 9, or 8 by 8
17	2 by 16, 3 by 14, 4 by 12, 6 by 10, or 7 by 9

Girders may be composed of several boards or planks side by side, care being taken to size accurately the pieces over bearings so they will act together. They should be spiked together and if 1-in. lumber is used with heavier stuff the thinner pieces should be inside. Girders should be braced or cross-bridged every four feet.

*From 'California Saftey News.'

†Safety engineer, Industrial Accident Commission of California, 525 Market street, San Francisco.

Book Reviews

A Treatise on Roads and Pavements. By Ira O. Baker. Third Edition. P. 658. Ill., index. John Wiley & Sons, Inc., New York. For sale by 'Mining and Scientific Press,' San Francisco. Price, $4.50.

It is significant of the rapid progress that has been made in highway engineering during the past few years that while the first edition of this standard treatise appeared 15 years ago and the second edition only five years ago, a great many more changes have been required in the third as compared with the second than were needed in the second edition as compared with the first. As might be expected, there are few changes in the first two chapters, on Road Economics and Road Administration and on Road Location. The principal changes to be noted in the chapter on Earth Roads include a fuller discussion of the road-drag and of oiling earth roads. Sand and sand-clay roads, which received little more than mention in the second edition, are given a chapter to themselves in the present volume. Few

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changes have been needed in the chapter on water-bound macadam roads, but attention is called to the fact that, while still representing an important type of highway, they are no longer the last word in highway construction. The material in the next four chapters, on Portland-Cement Concrete Roads, Bituminous Road Materials, Bituminous Surfaces for Roads, and Bituminous Macadam and Bituminous Concrete Roads, is almost entirely new, and summarizes the present state of knowledge regarding these important types of highways. There is relatively little new matter in the first five chapters of Part II, on Pavement Economics and Pavement Administration, Street Design, Street Drainage, Curbs and Gutters, and Pavement Foundations. The chapter on asphalt pavement contains an entirely new discussion of bitulithic, warrenite, topeka, and other special type of asphaltic concrete pavement. The principal new material in the chapter on brick pavements concerns wire-cut lug and hillside brick. In the chapter on stone-block pavements, considerable new matter has been added regarding durax blocks. The chapter on wood-block pavements has been enlarged considerably. Several short and relatively unimportant chapters appearing in the second edition regarding miscellaneous roads, bicycle-paths and tracks, equestrian roads, and race-tracks have been omitted. Like its predecessors, the present volume will be of great value to highway engineers and others interested in the construction and maintenance of streets and highways.

Treatise on Applied Analytical Chemistry. By Vittorio Villavecchia and others. Translated from Italian by T. H. Pope. Vol. I. Pp. 475, ill., index. P. Blakiston's Son & Co., Philadelphia, 1918. For sale by 'Mining and Scientific Press.' Price, $6.

Customs departments in most countries maintain laboratories in which products imported and exported are tested for valuation and standard purposes. The variety of analyses made covers a wide range, as will be seen by studying this work containing methods and standards for analysis of the principal industrial and food products. The author is director of chemical laboratories of the Italian Customs, and arranged the methods in collaboration with nine other chemists. Adulterations and impurities are found in most finished materials, and their determination constitutes a branch of chemistry worthy of cultivation by commercial, hygienic, and technical chemists, also by government inspectors. Volume I, the work under review deals with analyses of potable waters, acids, and chemical compounds, fertilizers, cement materials, metals and alloys, fuels, mineral oils, and fatty substances. Mine and smelter metallurgists will find much of value in this book. We like the concise arrangement of methods, and while it cannot be classed as elementary, yet the contents should be followed easily by students. Probably the translator is responsible for much of this desired brevity. As a practical work we commend it to chemists.

Petroleum Geology of Wyoming. L. W. Trumbull. Pp. 78. Ill., index. G. G. Bovee, Cheyenne, Wyoming. For sale by 'Mining and Scientific Press.' Price, $5.

This book contains the first comprehensive discussion of the subject that has been published. Hitherto, although a considerable part of the data contained in the present volume had been published, it was scattered through a number of Federal and State geological reports, while a good deal of it has never been published. The author is State geologist of Wyoming. The first part of the book is devoted to the geological history of the State, with particular regard to the oil-bearing horizons. A brief description is then given of each of the various oilfields, both producing and prospective. Geological sections are shown for the principal fields, as well as a number of well-logs. Land titles are discussed, also methods of leasing the State school-lands. There is an insert map of the entire State on a scale of about 20 miles to the inch, showing the principal geological features. The book contains a number of attacks on the policy of the General Land Office and other Federal officials, which, while perhaps excusable in a newspaper article, are, irrespective of the merits of the case, entirely out of place in a book of this character. The book will be of value to people directly interested in oil-development in Wyoming. Its usefulness would, however, have been materially increased if a chapter or two had been added regarding drilling and operating conditions in the various fields.

Popular Oil Geology. By Victor Zeigler. Pp. 144. Ill., index. C. H. Merrifield, Golden, Colorado. For sale by 'Mining and Scientific Press', San Francisco. Price, $2.50.

This book is based on a series of lectures recently delivered by the author, who states in the preface that it is not intended for the experienced oil geologist but rather for the man without technical training in this branch of geology. Writing a book on a technical subject for the non-technically trained reader is a difficult task. There is always danger either of explaining too much or not explaining enough. Thus the present author in discussing capillary pressure states that it is a function of the surface-tension of the liquid although it is probable that any reader who needed to have capillary pressure explained to him would stand in even greater need of a definition of surface-tension, and, for that matter, of function as well. Such shortcomings, however, are relatively unimportant, and the book as a whole should be valuable for the class of readers for which it is intended, particularly those who are interested in either the Colorado or the Wyoming oilfields. The first chapter is devoted to general history and statistics of the petroleum industry. The next discusses the physical and chemical properties of oil and gas, following which is a brief discussion of the various theories of the origin of oil and gas. Several chapters are then given to a discussion of those geological phenomena that affect the migration and accumulation of oil, and to the application of a knowledge of these phenomena to prospecting for oil. A chapter is devoted to the oil-shale industry, and the final chapter discusses oil investments.

Handbook of Hydraulics. By Horace W. King. Pp. 413. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by 'Mining and Scientific Press', San Francisco. Price, $3.

This book will be particularly valuable as a reference book for the practising engineer, although it will also be useful for the student. The opening chapters deal with hydraulic units and the fundamental principles of hydrostatics. Following this, the flow of water through orifices, over sharp-crested weirs and weirs not sharp-crested, through pipes, and in open channels is discussed in order. The next chapter considers methods and instruments for measuring water, and the preparation of discharge-records and expected storage-curves. The final chapter of the text deals with various special problems. There are two appendices, one on the comparison of weir formulas with experiments, and the other on the comparison of the Kutter, Manning, and Bazin formulas with the experiments recently made by F. C. Scobey of the U. S. Department of Agriculture. An unusually complete set of tables is included, comprising practically every mathematical table that the hydraulic engineer might need. There are also a number of diagrams and other illustrations.

Relief From Floods. By John W. Alvord and Charles B. Burdick. Pp. 169. Ill., index. McGraw-Hill Book Co., Inc.,

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New York. For sale by 'Mining and Scientific Press', San Francisco. Price, $2.

The curve of damage from floods in most countries shows a general tendency to rise and is likely to continue to do so unless more energetic and more intelligent measures are taken for flood-control. The present volume is particularly valuable as indicating what such measures should be. While many of the illustrations are naturally drawn from conditions in Ohio, with which the authors are most familiar, the general principles are equally applicable to flood-control problems in other parts of the world. The first chapter discusses damage from recent floods and the records of floods on different streams. Little credence is given to the popular belief that floods are increasing either in size or in frequency, or that deforestation, except in a few special cases, has much to do with increasing flood-volumes. The next chapters are devoted to methods of investigating flood-control problems and of predicting future floods from past records, particular attention being paid to the formulas developed by W. E. Fuller based on the ratio between average floods and the floods that may be expected once in a given period of years. The next chapter deals with channel improvements for protection against floods, including cut-offs, channel enlargement, and the construction of levees. The final chapter discusses flood-control by water-storage. There are a number of useful tables and diagrams included with the text.

Industrial Progress

POWERFUL ELECTRIC PASSENGER LOCOMOTIVES FOR THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

Electrification of the Chicago, Milwaukee & St. Paul Railway on the 440 miles of line over the Rocky Mountains has been so satisfactory in increasing operating efficiency that the decision has recently been made to electrify the 211 miles from Othello, Washington, over the Cascade range to Seattle and Tacoma. To handle passenger traffic over these two divisions, the company has ordered ten Baldwin-Westinghouse electric locomotives. The new locomotives will have a length of 90 ft. over couplings and will weigh 266 tons when ready for service. Each machine will have a single cab, extending over practically its entire length. The running gear consists of two units of the Pacific type placed back to back. Each unit will have a four-wheel guiding truck, three driving axles with 68-in. driving wheels, and a two-wheel trailing truck, connected by a heavy link. The cab will be free from pulling strains. Each locomotive will carry twelve motors, arranged in pairs permanently connected in series, each pair being geared to the same driving axle through a quill, whose spring mounting gives flexibility to withstand shocks. The only weight not spring-supported is that of the wheels, axles, and journal-boxes. Each locomotive can haul a 950-ton train of 12 coaches at the same schedule-speed made by two or three steam-engines. The capacity is 3200 hp. indefinitely, and 4000 hp. for one hour. At starting, a pull of 112,000 lb. can be exerted on a train. The normal maximum speed on level track is 60 miles per hour and 25 miles per hour up a 2% grade. One great advantage of the electric locomotive is its efficiency over a wide range of speeds. For these locomotives there are nine economical running-speeds, ranging from 8 to 56 miles per hour. These are secured by various series and parallel groupings of the motors, and by placing shunts around the fields. In connection with the arrangements for regenerative braking each locomotive has generators geared to the axles of the pony-trucks. These supply current to excite the main-motor fields during regeneration; at other times they supply current for the air-compressors. When this supply is not available, the compressors take power from a small motor-generator set, or from the control storage-battery. Thus a constant supply of compressed air is available at all times whether the trolley is energized or not. To ensure train-heating independent of trolley conditions, each locomotive will carry an oil-fired steam-boiler with storage-tanks for 750 gal. of oil and 7500 gal. of water. Running gears and mechanical details for these locomotives will be furnished by the Baldwin Locomotive Works and electric equipment by the Westinghouse Electric & Manufacturing Company.

THE CINCH ANCHORING SYSTEM

The need of an adequate system of fastening ornamental and structural fixtures to concrete, cement, and other masonry was not met fully until the introduction of the Cinch system. A Cinch expansion-bolt consists of a conical-wedge male part of malleable iron either plain or threaded, and a lead-composition female part. The plain two-unit anchorage consists of two of each of the above parts, neither of which is threaded, while for a threaded two-unit anchorage one of the iron parts is threaded. There are three kinds

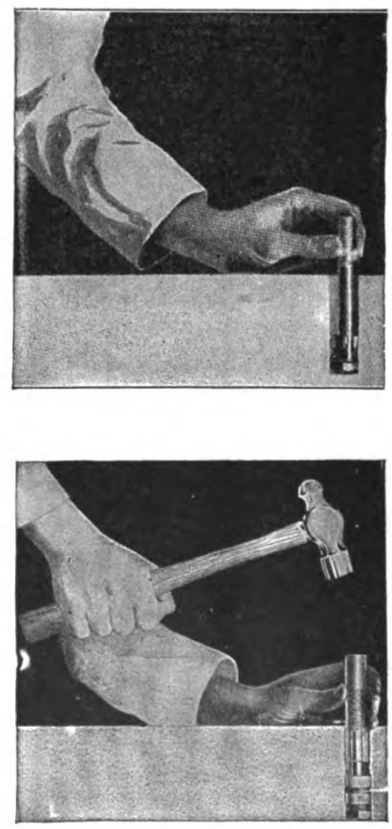

FIG. 1 AND 2. PLACING AND CAULKING UNITS

of Cinch anchorage specialties—the Cinch expansion-bolt, Cinch anchor and Cinch stud-anchor all of which are combination of the units above described, together with either a standard machine-bolt or a stud-bolt. Since these anchorages are made of malleable-iron and lead-composition units, a complete cylindrical surface-contact is made with the walls of the hole, whether it be regular or irregular. Vibration will not loosen the hold since all parts are under complete restraint.

As shown in Fig. 1 the head of the bolt and the first unit are first placed in the hole. The unit is expanded by means

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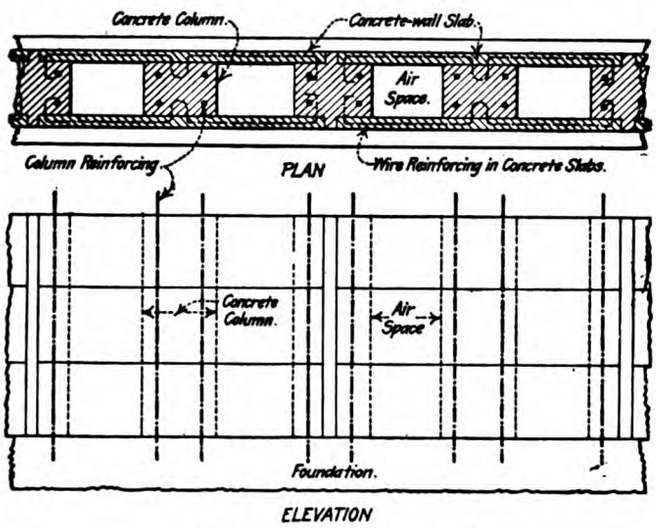
of the caulking tool as shown in Fig. 2. Other units are added as required, each unit being expanded as it is put in place. After all have been expanded the piece to be hung is placed and the nut screwed on the bolt, an operation of but a few seconds. When it is desired to use a stud-bolt or to have the head of the bolt outside the work the same caulking method is employed. A threaded iron wedge is screwed upon the end of the stud-bolt and with the first alloy is placed in the hole. This is caulked in place and is followed by a plain iron wedge with its alloy which is also caulked in place. The stud-bolt can now be unscrewed, leaving the expanded units in the hole. When ready to attach the work the bolt is engaged with the threaded wedge in the bottom of the hole. A plain piece of pipe can be used instead of the caulking tool if desired. These Cinch anchorages are carried in stock by Harron, Rickard & McCone, of San Francisco.

CONCRETE-WALL CONSTRUCTION

A novel system for constructing concrete walls has recently been developed by the Worswick Street Paving Co., of Fresno, California. Concrete slabs 1½ by 12 in. wide and from 1 to 4 ft. long, reinforced with one to three wires, are



SYSTEM OF WALL CONSTRUCTION.

cast. The wires are bent at the ends, and, if desired, at the centres. The use of these slabs makes it possible to reduce the amount of form-lumber materially. Walls can be built solid of either plain or reinforced concrete, but this system is particularly advantageous in building hollow walls with reinforced columns as shown in the accompanying sketch. The thickness and spacing of the columns, the amount of reinforcement, and the thickness of the wall can be varied to suit the conditions. The outside slabs can be waterproofed for basement-walls.

TRACTOR AND IMPLEMENT SHOW AT DAVIS

A tractor and implement demonstration of unusual interest was held at Davis, California, April 17-19 under the auspices of the California Tractor and Implement Association. The exhibition was held in several tents near the University of California Farm and the machines were demonstrated by actual plowing and other work on an adjoining field containing several hundred acres. Tests of the various machines were made for draw-bar pull and turning radius were made by J. B. Davidson, of the University Farm. No less than 41 different models of tractors were exhibited by 24 companies, including the Union Tractor Co., the Cleveland tractor, represented by F. H. Stow; the Wallis tractor, represented by George Collins; the California Tractor Co.; the Lauson tractor, represented by the De Laval Dairy Supply Co.; the Holt Manufacturing Co.; the Los Angeles Auto Tractor Co.; the Fageol tractor, represented by Butler-Veitch Co.; the Fitch tractor, represented by Fred Walsh; the International Harvester Co.; the Yuba Manufacturing Co.; the Bean Spray Pump Co.; the Dauch Manufacturing Co.; W. A. Ekberg Co.; Russell & Co., represented by A. H. Averill Machinery Co.; W. L. Cleaveland & Sons; the Advance-Rumely Thresher Co.; Sacramento Valley Tractor Co.; Pacific Coast Tractor Co.; Samson Sieve-Grip Tractor Co.; the Avery tractor, represented by F. H. Poss Co.; C. L. Best Gas Traction Co.; California Moline Plow Co.; and the Trundaar tractor, represented by Hamilton & Nickell. Plows, harrows, subsoilers, and other implements were exhibited by the Holt Manufacturing Co., Killefer Manufacturing Co., International Harvester Co., Yuba Manufacturing Co., H. G. Knapp & Son, John Deere Plow Co., Oliver Chilled Plow Co., Baker & Hamilton, Schmeiser Manufacturing Co., Pacific Implement Co., and California Moline Plow Co. The tractors varied in size from small machines of 5, 6, and 8 hp. for orchard and vineyard work up to 75 hp., for the heaviest plowing. Besides the tractors and cultivating implements there were many other exhibits showing the application of power-driven machinery to farm needs. The motor trucks exhibited included the Bethlehem-Renstrom, Brockway-Hersch, Burman, Sheldon, Denby, Fageol, Ford, Garford, Heath-Duplex, Hewitt-Ludlow, Indiana, Kissel, Maxwell, Nash, General Motors Co., Packard, Reo, Signal, Stewart, and White. Exhibits of gasoline, distillate, and lubricating oils and greases were made by the Standard Oil Co. and the Union Oil Company.

Engineering Societies

Idaho Society of Engineers. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of **American Society of Mechanical Engineers.** Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of **American Institute of Electrical Engineers.** Edward Woodbury, secretary, 255 East 3rd street.

Oregon Society of Engineers. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, **American Institute of Electrical Engineers.** Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of **American Society of Civil Engineers.** J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Section of **American Society of Civil Engineers.** N. A. Bowers, secretary, Rialto building.

San Francisco Section of **American Society of Mechanical Engineers.** Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of **American Institute of Electrical Engineers.** A. G. Jones, 811 Rialto building.

Southern California Association of Members of **American Society of Civil Engineers.** Wilkie Woodward, secretary, 435 Consolidated Realty building, Los Angeles.

Utah Society of Engineers. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

The regular bi-monthly meeting of the San Francisco Association of Members of the American Society of Civil Engineers was held April 16. F. H. Fowler, district hydroelectric engineer for the U. S. Forest Service, presented an illustrated paper on 'The Water-Power Supply of California.'

A joint meeting of the Oregon Society of Engineers, the Northwestern Association of Highway Engineers, and the

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Portland sections of the American Society of Civil Engineers, American Institute of Electrical Engineers, and National Electric Light Association, was held at Portland on March 21. E. B. Thompson delivered an illustrated lecture on 'The Oregon City Locks.'

The San Francisco Sections of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and American Chemical Society gave a dinner on March 20 in honor of George F. Swain, professor of civil engineering at the Massachusetts Institute of Technology. Benjamin Ide Wheeler, president of the University of California, presided during the early part of the evening, and his place was taken later by C. D. Marx. Professor Swain delivered an address on' National Issues of the Day.' Short speeches were also made by P. M. Downing, D. M. Folsom, and Max Thelen.

Personal

Major **Charles B. Wing** has arrived in France.

Captain **E. T. Thurston Jr.**, has arrived in France.

W. G. Peters has been appointed city engineer of Chehalis, Washington.

C. M. Adams has been appointed city engineer of Bellingham, Washington.

Jay A. Hinman, formerly city manager of Hanford, California, has resigned.

Kirby S. Heck has been appointed city harbor engineer for Oakland, California.

G. Walter Hunt, city engineer of San Jose, California, has enlisted in the naval reserves.

C. H. Purcell, bridge engineer for the Oregon State Highway Department, has resigned.

A. H. Babcock has been appointed western representative of the Naval Consulting Board.

J. F. Birney has been appointed assistant county engineer for Whitman county, Washington.

Allen Hazen and **William H. Burr** have been appointed consulting engineers for the Spring Valley Water Company.

S. J. Lisberger and **R. H. Ballard** are members of the convention committee of the National Electric Light Association.

William L. Wales has been appointed consulting engineer for the newly-formed Surprise Valley irrigation district in Modoc county, California.

L. H. Nishkian, formerly structural engineer for the Board of Public Works of the city of San Francisco, has resigned to become chief engineer for Macdonald & Kahn, contractors, of San Francisco.

James B. Black, formerly assistant general agent for the Great Western Power Co., has taken over the duties formerly discharged by **W. W. Briggs**, and has been given the title of general sales manager.

Robert A. Booth has been appointed a member of the Oregon State Highway Commission, succeeding **E. J. Adams**, whose term expired. The other members of the Commission are **S. Benson** and **W. L. Thompson.**

C. E. Hickok, formerly city engineer of Alameda, California, has reported for duty at an officers' training camp in the East. During his absence, assistant city engineer **Burnett Hamilton** will have charge of the city engineer's office.

A. C. McLaughlin, formerly chief of staff for the fuel oil department of the Southern Pacific Co., has been appointed assistant to **William Sproule**, president of the Associated Oil Co. The duties of this position will include those of vice-president and general manager until a successor is elected to **R. P. Schwerin**, who resigned.

Commercial Paragraphs

The Westinghouse Electric & Manufacturing Co. has acquired the sole marketing rights for the United States for Frankel solderless connecters.

The Builders' Exchange of San Francisco has elected the following directors: Robert Dewar Sr., R. A. Chisholm, C. W. Withington, George Forderer, E. J. Brandon, R. J. H. Forbes, E. S. Rainey, W. W. Hayes, J. D. McGillivray, Henry Jack, A. Mennie, and C. Larsen.

The F. C. Austin Co., Inc., Chicago, Illinois, has recently issued an 84-page catalogue describing the cube concrete-mixers manufactured by the company. There are many illustrations showing both the mixers themselves and also the various classes of work on which they have been used.

The Building Industries Association of San Francisco, formerly the General Contractors' Association, has elected the following officers for the ensuing year: president, C. W. Gompertz; first vice-president, H. P. Stow; second vice-president, D. Zelinsky; treasurer, R. G. Guyett; secretary, P. M. Wuillemin.

A special committee of the machine Tool and Machinery Trades, with headquarters at 334 Fourth avenue, New York, did service in soliciting subscriptions for the Third Liberty Loan. The officers of the committee included J. W. Lane, chairman; R. L. Patterson, vice-chairman; Charles B. Houston, secretary; Norman Dodge, director of speakers; and C. A. Hirschberg, publicity director.

The American Cement Machine Co. has recently issued Catalogne No. 18 and Bulletin P-18. Catalogue No. 18 contains 40 pages and describes the 'Boss' concrete mixers both for paving and building work manufactured by the company. Hoists, elevators, back-fillers, concrete-carts, and contractors' pumps are also listed. Bulletin P-18 describes in detail the Packard low-charging concrete-mixer.

Henry P. Bope has resigned his position as vice-president and general manager of sales for the Carnegie Steel Co. to devote his time to private interests. He has been succeeded by William G. Clyde, formerly assistant general manager of sales for the company in charge of the bureau of bars and hoops. Charles L. Wood, formerly assistant to Mr. Clyde, has been appointed to succeed him as assistant general manager of sales.

The Wheeler Condenser & Engineering Co., of Carteret, N. J., have published its Bulletin No. 108-B describing the centrifugal pumps manufactured by the company. The bulletin shows turbine-driven geared centrifugal pumps; bi-rotor; tri-rotor; electric-driven; small belt-driven; small high-speed; side, end, and bottom suction; vertical shaft; pumps for either series or parallel operation; and special slow-speed engine-driven pumps. Test-curves are included in the bulletin.

New Publications

Steel Derricks and Drilling Rigs. Fifth edition. The Carnegie Steel Co., Pittsburgh, Pennsylvania. 96 pp. This useful book describes the steel derricks and rigs manufactured by the company, from the 72-ft. standard rig weighing 45,700 lb., to the 106-ft. heavy California combination rig weighing 80,900 lb. in all. Besides a number of photographs of rigs in use, drawings are given showing the various parts of the rigs, with their dimensions. Full directions are given for erecting the rigs. The book may be obtained from the U. S. Steel Products Co., Rialto Bdg., San Francisco, and should be on the desk of every oil operator.

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Construction News Summary

STREET AND ROAD WORK

Bay Point, Cal.—Contract for grading and construction of concrete curbs and sidewalks, water, sewer, and electric lighting systems at Pacific Shipbuilding Co.'s new town of Clyde has been awarded to Bos & O'Brien, Hearst Bdg., San Francisco.

Corte Madera, Cal.—Contract for improvement of several streets has been awarded to R. De Lucca for about $50,000.

Davenport, Wash.—Contract for construction of permanent highway No. 4 has been awarded to G. L. Stickler for $36,000.

East San Diego, Cal.—Contract for construction of 5-in. concrete pavement on University avenue has been awarded to Thomas C. Breitenstein, 465 Van Wyck street, Pasadena, at $0.16 per sq. ft. or $18,489.60 in all.

Lodi, Cal.—Contract for paving North School street from Elm street to the city limits has been awarded to Clark & Henery Construction Co., Stockton, for $0.1825 per sq. ft., or $25,000.

Los Angeles, Cal.—Contract for improvement of 8th street has been awarded to George R. Curtis, 2440 East 26th street, Los Angeles, for $10,089.59.

Contract for grading, paving, and construction of reinforced concrete stairways on Cove avenue has been awarded to M. W. McCombs, 1654 West 36th street, Los Angeles, for $7404.46.

Napa, Cal.—Following bids were received for completion of Greenwood Hill highway, comprising about two miles of concrete pavement: J. H. Hein, $15,000; Thomas A. Clark, $17,180.30; A. H. Vogt, $19,992. All bids were rejected and work will be done by day-labor.

Redwood City, Cal.—Contract for improvement of Vera avenue has been awarded to A. Hess & Co., Redwood City, for $10,475.

Riverside, Cal.—Contract for construction of macadam roads in Palo Verde valley has been awarded to Johnson-Shea Co., Riverside, for $238,000.

Contract for construction of macadam road to connect Government aviation field with Riverside-Perris road has been awarded to Johnson-Shea Co. for $3475.86.

Sacramento, Cal.—A. H. Vogt, San Francisco, was low bidder and was awarded the contract for construction of 0.7 mile of State highway at Riverbank in Stanislaus county, including an over-grade crossing over the Santa Fe tracks, for $13,726.75. Other bidders were: A. J. Grier, $13,942; C. E. Cotton, $19,326; M. Blumenkranz, $19,841. Engineers' estimate was $16,382.33. State will furnish reinforcing-steel, corrugated pipe, cement, sand, coarse aggregate, manhole castings, bearing plates, and a steel ladder, valued at $6099.30.

W. E. Hall and R. L. Baskerville, San Diego, were low bidders for construction of 2.4 miles of State highway through the city of El Cajon in San Diego county, for $22,835.50. Other bidders were: Olaf Nelson, $23,335.70; W. N. Hendricks and M. S. Cummings, $23,659.50; G. W. Tuttle Co., $23,726.27; Macrae & Layaz, $25,363.60. Engineers' estimate was $21,700.39. State will furnish pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $11,484.40.

Salem, Ore.—Federal Government has approved plans for construction of 48.45 miles of the John Day highway through Wheeler and Grant counties. Estimated cost is $400,433.74, which will be divided as follows: Federal Government, $157,216; State, $157,216; Wheeler county, $36,000; Grant county, $50,000.

Salinas, Cal.—Contract for macadamizing 6 miles of the Salinas-Watsonville road has been awarded to Granite Rock Co., Salinas, the only bidder, at $37,262.88.

San Bernardino, Cal.—Contract for grading and construction of 4-in. concrete pavement on 10th street has been awarded to W. D. Bohan, 637 Seventh street, San Bernardino, at $0.089 per sq. ft. or $5810.90 in all. Highway Construction Co. bid $0.11 per square foot.

San Francisco, Cal.—Contract for improvement of Liberty and Sanchez streets has been awarded to O. G. Ritchie, Chronicle Bdg., San Francisco.

Contract for improvement of 44th street between Anza and Fulton streets has been awarded to Fay Improvement Co., Phelan Bdg., San Francisco, for $22,750.

San Rafael, Cal.—Contract for construction of the Miller Hill road has been awarded to S. P. Brownlee, Ross and Marin streets, San Rafael, for $10,000.

Santa Barbara, Cal.—Contract for grading and paving 8901 lin. ft. of highway in the Mesa district has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $32,000. A. L. Pendola bid $33,250 or else $22,585 if the county furnished the cement. C. T. Richardson bid $34,971.

Contract for paving Loma street has been awarded to A. L. Pendola, 1332 Garden street, Santa Barbara, at $0.17 per sq. ft. for 4-in. concrete pavement and $0.50 per ft. for concrete curbs, a total of $3757.66. Fairchild-Gilmore-Wilton Co. bid $4040.70.

Seattle, Wash.—Bids will be received until May 20 by county commissioners for grading 6000 lin. ft. of highway between Auburn and Enumclaw. Estimated cost is $12,000.

Contract for construction of 3.5 miles of concrete pavement on the Wayne-Juanita road has been awarded to Hoover & Co., Everett, for $94,044.80. Sparger Construction Co. bid $106,000.

Contract for construction of 3.6 miles of concrete pavement on the Juanita-Kirkland-Houghton road has been awarded to J. L. Smith, Seattle, for $86,000.

Kaiser Paving Co., Everett, was low bidder at $205,813.92 for construction of concrete pavement on the Auburn-Enumclaw road. P. M. Morgan bid $219,901.30. Contract was awarded to Kaiser Paving Co., but the length of the road to be improved was reduced two miles and the contract price reduced to $157,780.

Allred, James & Ward, Centralia, was the only bidder at $58,000 for grading and graveling the Wilkenson road. Bid was rejected.

Contract for grading, laying water-mains, and construction of wooden curbs and concrete sidewalks on streets in West Seattle has been awarded to D. H. Traphagen, Walker Bdg., Seattle. Estimated cost is $80,000.

G. A. Banderet was low bidder at $9999 for construction of 1.1 miles of the Julia Blinn road. J. Jacobson bid $11,899.51. Bids were rejected and work will be done by day-labor.

Spokane, Wash.—Contract for construction of 4.1 miles of concrete pavement on the Sunset boulevard has been awarded to Clifton, Applegate & Toole, Spokane, for $84,925. Engineer's estimate was $68,240.

Contract for construction of 3½ miles of concrete pavement on the Normal road from Hazlewood south has been awarded to C. M. Payne, Spokane, for $61,062. Engineer's estimate was $56,999.

Contract for construction of gravel-macadam surface on highway from Medical Lake north to the Sunset boulevard, 4½ miles, has been awarded to Spokane Bitu-Mass Paving Co., Spokane, for $36,250.

Contract for grading and graveling the Wells road has been awarded to J. I. Daniel and S. A. Eslick, Spokane, for $43,377.

Visalia, Cal.—Contract for construction of the Merryman-Lemon Cove division of the county highway system has been awarded to the Highway Construction Company.

Contract for construction of county highway from Strathmore west, 4.25 miles, has been awarded to Brady & Flinn, Humboldt Bank Bdg., San Francisco.

Washington, D. C.—Department of Agriculture has approved project for construction of highway along Trinity river from Weaverville to Eureka, and has appropriated $665,000 for the work. State of California will provide $393,240 and Humboldt county $200,000. This will permit early construction of the highway.

SEWERS AND DRAINAGE

King City, Cal.—John Heafy, 22 Mesa avenue, Oakland, was low bidder at $13,450 for construction of sewer system. Other bidders were T. E. Clinch, $15,645; Fred Meyer, $16,562.62; Edward O'Malley, $18,000; A. P. Beck, $19,956; Russell & Fernandez, $19,993; B. Byrne, $20,700; S. Ruthven, $23,717.

Los Angeles, Cal.—Contract for construction of vitrified-pipe sewer on West boulevard between 16th and Lomita streets has been awarded to S. Zarubica, 3006 Sixth avenue, for $11,700.

Modesto, Cal.—P. F. Jones is preparing plans for con-

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struction of three drainage-ditches for the Modesto irrigation district. Estimated cost is $75,000.

Poplar, Mont.—Contract for construction of sewer system has been awarded to C. H. Kelley for $54,131.

Richvale, Cal.—Contract for construction of about 60 miles of lateral drains for drainage district No. 100 has been awarded to Kenyon & Whitman Co., Forum Bdg., Sacramento. Estimated cost is $60,000.

Stockton, Cal.—Bids will be received until May 21 by G. W. Pulich, city clerk, for construction of two main sewage-disposal plants. Alternate bids will be received for Imhoff tanks and for Reinsch-Wurl screens. F. H. Tibbetts, Alaska Commercial Bdg., San Francisco, is consulting engineer.

BRIDGES AND CULVERTS

Eureka, Cal.—Contract for construction of suspension bridge over Mad river has been awarded to Thomas Englehart, 210 B street, Eureka, for $7250. G. M. Moore bid $7495.

Contract for construction of bridge across Willow creek has been awarded to H. Padgett and F. E. Kelly for $1890. Other bidders were H. A. Poland, $1925; G. M. Moore, $2575; Thomas Englehart, $3000.

H. J. Brunnier, Sharon Bdg., San Francisco, is preparing plans for concrete viaduct over Eel river. Estimated cost is $60,000.

Hollister, Cal.—Contract for surfacing bridge across San Benito river on the Hollister and San Juan road has been awarded to Granite Rock Co., Salinas, the only bidder, for $1196.10.

Martinez, Cal.—Bids will be received until May 20 by J. H. Wells, county clerk, for construction of a reinforced concrete bridge on the State highway across Rodeo creek at Rodeo.

Modesto, Cal.—Bids will be received until May 14 by H. Benson, county clerk, for construction of bridge over Rock creek six miles north of Eugene.

Bids will also be received until the same time for construction of 300-ft. bridge over Dry creek near Waterford.

Olympia, Wash.—Contract for construction of reinforced concrete bridge across Stillaguamish river at Sylvana has been awarded to Monson Construction Co., Portland, for $39,135.50.

Contract for construction of 80-ft. concrete arch-bridge over the south slough near Sylvana has been awarded to Reinseth & Haversland, Arlington, for $11,918.

San Francisco, Cal.—Contract for construction of concrete foundations for viaduct across Embarcadero at the foot of Market street has been awarded to J. Spargo, 240 Montgomery street, San Francisco, for $11,200. Other bidders were J. D. Hannah, $13,773; McLeran & Peterson, $14,285; Healy-Tibbitts Construction Co., $15,558; Tibbitts-Pacific Co., $17,897. Contract for the steel work has already been awarded to the Ralston Iron Works, San Francisco, for $19,865. Work may delayed because of lack of steel.

San Jose, Cal.—Bids will be received until May 13 by T. H. Reed, city manager, for construction of reinforced concrete bridge across Coyote creek at Santa Clara street in place of the one that failed last October.

Santa Rosa, Cal.—Bids will be received until May 15 by W. W. Felt, Jr., county clerk, for construction of a reinforced concrete slab-culvert on the Petaluma and Santa Rosa road near Kawana Springs.

Contract for construction of two reinforced concrete bridges on State highway over Petaluma creek has been awarded to W. L. Proctor, Santa Rosa, for $10,960.70.

Seattle, Wash.—Following bids were received by county commissioners for construction of a 96-ft. steel bridge at North Bend: C. Geske & Co., $13,732; Coast Bridge Co., $13,800; J. R. Wood, $14,700; C. L. Graves, $14,700; C. G. Huber, $14,800. All bids were rejected and work will be re-advertised.

Contract for construction of bridges across Miller and Skykomish rivers has been awarded to Fleines & Dahl, Seattle, for $10,475. C. G. Huber bid $12,585.

IRRIGATION AND WATER SUPPLY

Modesto, Cal.—Directors of Modesto and Turlock irrigation districts have decided to co-operate in investigation of the feasibility of the proposed Don Pedro reservoir.

Oxnard, Cal.—Contract for construction of three reinforced concrete reservoirs for the American Beet Sugar Co. has been awarded to Leonardt & Peck, H. W. Hellman Bdg., Los Angeles, for $62,000.

San Francisco, Cal.—State Water Commission has received the following applications for permission to divert water for irrigation.

Colusa Land & Water Co., San Francisco, 200 second-feet from Sacramento river. Plans include main canal 8.7 miles long and two pumping plants, each consisting of a 42-in. pump driven by a 400-hp. motor and two 26-in. pumps, driven by 200-hp. motors. Estimated cost of work is $219,890.

Lindsay-Strathmore irrigation district, 75 second-feet from Kaweah river. Estimated cost of additional work is $20,000.

State Water Commission has granted the following permits to divert water for irrigation:

Tisdale Irrigation & Drainage Co., San Francisco, 29¼ second-feet from Sacramento river in Sutter county. Plans include one 75-hp. and one 40-hp. gas-engine, one 18-in. and one 12-in. centrifugal pump and a main ditch 3½ miles long.

Reclamation district No. 108, 500 second-feet from Sacramento river. Plans include main canal 16 miles long. Estimated cost is $75,000.

Pierre Ducasse, Termo, 1435 acre-feet from streams in Lassen county. Plans include earth dam and ditch one mile long. Estimated cost is $12,000.

Cy and William Moreing, Stockton, 3.55 second-feet from Littlejohn creek. Plans include pumping-plant and ditch two miles long. Estimated cost is $4000.

Stockton, Cal.—Formation of proposed Woodbridge irrigation district has been defeated at election.

Tracy, Cal.—Following bids were received by West Side irrigation district for work under contract No. 14, which includes 500 cu. yd. excavation, 120 cu. yd. reinforced concrete, and 10,000 ft. B.M. lumber: J. E. Johnson, Tracy (awarded contract), $3565; C. H. Laiblin, $4925. Bos & O'Brien also bid on this work.

C. H. Laiblin, Manteca, has been awarded contract for $8851.80 for work under contract No. 15, which includes 3000 cu. yd. excavation and 24 small bridges. Other bidders were A. J. Grier, $9096; Bos & O'Brien, $9702; J. E. Johnson, $9995.

Washington, D. C.—Contract for construction of water-supply connection at the Puget Sound Navy Yard has been awarded to W. H. Mitchell for $23,900.

LIGHT, HEAT, AND POWER

Redding, Cal.—Expenditure of $40,000 for construction of municipal lighting plant has been approved.

San Francisco, Cal.—State Water Commission has received the following applications to divert water for power:

W. O. Lusk, Los Angeles, 250 second-feet from Pit river and its tributaries. Plans include ditch and pipe-line 6½ miles long. After this water is used for power development it is to be carried in a ditch and pipe-line 30 miles long for irrigation. Total estimated cost is $250,000.

E. C. Latchem, Gazelle, 12 second-feet from creek in Siskiyou county. Plans include dam and ditch 2½ miles. This water is also to be used for mining.

RIVER AND HARBOR WORK

Oakland, Cal.—Contract for dredging at new shipyard of Union Construction Co. on Oakland water front has been awarded to San Francisco Bridge Co., Nevada Bank Bdg., San Francisco. Contract for furnishing piles has been awarded to C. K. Spaulding Logging Company.

Richmond, Cal.—Contract for construction of creosoted pile trestle at municipal wharf has been awarded to Hyde, Harjes & Co., San Francisco, for $24,700. Healy-Tibbitts Construction Co. bid $25,155.

Contract for construction of clay bulkhead at inner harbor has been awarded to P. A. Haskell for $22,702.50. American Dredging Co. bid $26,395.75.

Sacramento, Cal.—Contract for construction of south-side levee along Sacramento river has been awarded to Clark & Henery Construction Co. for $36,000.

San Diego, Cal.—A. W. Tweeden Co. was low bidder at $412,160 for dredging work in San Diego harbor. San Francisco Bridge Co. bid $549,596. There is only $340,000 available for the work. The Tweeden company will probably be awarded contract for part of the work, leaving the remainder to be done at some later time. The total amount of material is 1,384,000 cubic yards.

San Francisco, Cal.—Following bids were received at U. S. Engineer Office for furnishing a dredge for work on the Sacramento, San Joaquin, Feather, and Mokelumne rivers: Bethlehem Shipbuilding Co., 260 California street, San

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Francisco, $1000 per month; Ajax Dredging Co., 249 First street, San Francisco, $6 per hour for dredging and $4 per hour for towing; Caledonia Dredging Co., Merchants Exchange Bdg., San Francisco, $7.50 for dredging and $4 for towing.

RAILROAD WORK

Alameda, Cal.—A. J. Grier, 525 Market street, San Francisco, was low bidder at $26,568.35 and was awarded the contract for construction of municipal railroad. Other bidders were: Federal Construction Co., $27,641.40; Healy-Tibbitts Construction Co., $27,803.90; R. H. Mahoney & Co., $30,129.50; Eaton & Smith, $31,529.90.

Princeton, B. C.—Contract for construction of 14-mile railroad from Princeton to Copper mountain for Canada Copper Corporation has been awarded to W. P. Tierney, but work will not be commenced unless the corporation receives a favorable decision from the Government regarding the amount of the corporation's income tax. Construction of 140 miles of power-transmission line is also dependent on this income-tax decision.

Seattle, Wash.—D. W. Rutherford was low bidder at $41,262 for construction of municipal railroad. Lester & Monahan bid $61,204.

BUILDING CONSTRUCTION

Adams, Ore.—Contract for construction of school-building has been awarded to Albert Thomason, Milton, for $21,751.80. Contract for plumbing and heating has been awarded to R. H. Thompson, Pendleton, for $6644 and for electric wiring to Charles Milne, Pendleton, for $650.

Crockett, Cal.—Contract for construction of several brick and steel buildings for California-Hawaiian Sugar Refining Co. has been awarded to Lindgren Co., Monadnock Bdg., San Francisco, on a cost-plus-percentage basis. Estimated cost is $200,000.

Fresno, Cal.—Contract for construction of first unit of reinforced concrete packing-plant for Rosenberg Bros. & Co. has been awarded to Clinton Construction Co., 140 Townsend street, San Francisco, for about $300,000.

Hamilton City, Cal.—Contract for construction of grain-elevator for Andrew Kaiser has been awarded to John Berlinger for $25,000. Five more elevators will be erected by Mr. Kaiser.

Honolulu, Hawaii.—Contract for construction of buildings, roads, and water and sewer systems at aviation base at Ford island has been awarded to Walker & Young, Honolulu, at $63,975. Other bidders were Hawaiian Dredging Co., $64,718.42; Lord-Young Engineering Co., $69,925; Honolulu Planing Mill, $98,200.

Contract for construction of concrete and hollow-tile gymnasium and store building at Pearl Harbor has been awarded to C. L. Wold, 75 Sutter street, San Francisco, for $36,000.

Los Angeles, Cal.—Contract for construction of five-story class A building for S. W. and H. E. Bixby has been awarded to C. J. Kubach Co., Merchants National Bank Bdg., Los Angeles.

Contract for making alterations in State Exposition building at Exposition park has been awarded to Leppey & Laisy, 3704 West Washington street, Los Angeles, for $13,246.

Contract for construction of brick building for Mrs. A. E. Rose has been awarded to Milwaukee Building Co., Wright & Callender Bdg., Los Angeles, for $20,000.

Contract for construction of frame and corrugated-iron cannery-building and brick boiler-house at San Pedro for the Seacoast Canning Co. has been awarded to F. W. Colegrove, 573 7th street, San Pedro, for $23,000.

Oakland, Cal.—Contract for construction of four steel and concrete buildings for American Can Co. has been awarded to Lindgren Co., Monadnock Bdg., San Francisco, for $248,000. Lindgren Co. already has contract for construction of first unit of plant, costing $160,000.

Contract for construction of frame and plaster apartment-house for L. B. Hoge has been awarded to H. P. Nelson, 2251 Grove street, Berkeley, for $28,695.

Contract for construction of frame machine-shop for Scandia Pacific Oil Engine Co. has been awarded to C. A. Perkins, 1412 Golden Gate avenue, San Francisco, for $18,600.

Okanogan, Wash.—Contract for construction of reinforced concrete and brick store-building for C. E. Blackwell & Co. has been awarded to John T. Francis, Okanogan, for $50,000.

Portland, Ore.—Dinwiddie Construction Co., which was awarded contract for construction of municipal grain-elevator at St. Johns, has been allowed to withdraw its bid of $698,900. Contract has been awarded to Grant Smith & Co., Portland, for $798,383.

Sacramento, Cal.—Following contracts for work on State Agricultural Pavilion have been awarded: Excavation, concrete work, and ornamental-iron work to E. T. Leiter & Sons, Inc., Call Bdg., San Francisco. Furnishing steel, to Central Iron Works, who have sub-let the work to Dyer Bros., San Francisco. Erection of steel, to Dyer Bros. Plumbing and heating, to F. W. Snook Co., San Francisco. Electric wiring to Latourrette-Fical Co., Sacramento. Architectural terra cotta, to N. Clark & Sons, San Francisco. Terra-cotta roofing, to Gladding-McBean Co., San Francisco.

Hayes-Oser Co., Call Bdg., San Francisco, were low bidders at $64,247 for construction of two buildings at Agnews State Hospital. Other bidders were L. G. Bergren & Son, Inc., $64,440; G. W. Boxton & Son, Inc., $64,900; W. D. Henderson, $66,360; R. W. Littlefield, Oakland, $66,943; W. G. Thornally, Oakland, $68,650; Monson Bros., $70,608; Frank Gallagher, $71,200; Charles Stockholm & Son, $76,450; E. T. Leiter & Son, Inc., $78,487. O. Monson bid $29,570 for one of the buildings. All San Francisco bidders unless otherwise noted.

San Diego, Cal.—Contract for construction of two temporary frame buildings at aviation school has been awarded to Lange & Bergstrom, Sharon Bdg., San Francisco, for $23,300.

San Francisco, Cal.—Contract for furnishing steel for addition to Mills building has been awarded to California Steel Co., Hobart Bdg., San Francisco.

Contract for construction of reinforced concrete building at 18th and Shotwell streets for the Hind Co. has been awarded to W. Knowles, Hearst Bdg., San Francisco, for $33,000.

Contract for construction of machine-shop for Associated Oil Co. at Illinois and El Dorado streets has been awarded to MacDonald & Kahn, Rialto Bdg., San Francisco, for $36,000.

Contract for construction of building opposite pier No. 26 for Tillman & Bendel has been awarded to Clinton Construction Co., San Francisco.

Contract for construction of reinforced concrete building at First and Howard streets for W. R. Berry has been awarded to W. T. Commary, Crocker Bdg., San Francisco, for $20,000.

Contract for construction of class C garage on O'Farrell street near Taylor street has been awarded to Val Franz & Son, San Francisco, for $33,180.

Contract for making alterations and additions at Graney Billiard Parlors at Market and Fifth streets has been awarded to Grace & Bernieri, Spreckels Bdg., San Francisco, for $26,172.

Contract for construction of frame apartment-house on Washington street near Polk for W. F. Dunn has been awarded to Ruegg Bros., Pacific Bdg., San Francisco, for $25,975.

Contract for construction of concrete and mill-construction building for Bowie Estate Co. has been awarded to H. S. Williams, Hearst Bdg., San Francisco, for $50,000.

Joseph Cahen, 333 Kearny street, San Francisco, is preparing plans for warehouse to be built for Milton Auerbach on Second street near Harrison. Estimated cost is $35,000.

Contract for construction of reinforced concrete and galvanized iron factory-building for the Fleischmann Co. on Minnesota street near 25th has been awarded to C. W. Hansen, 180 Jessie street, San Francisco, for $20,000.

San Jose, Cal.—California Packing Corporation, 101 California street, San Francisco, will construct reinforced concrete warehouse.

Contract for making alterations in store of O. A. Hale Co. has been awarded to R. O. Summers, 17 North First street, San Jose, for $20,000.

Seattle, Wash.—Charles Haybes, Mehlborn Bdg., Seattle, has completed plans for frame apartment-house to be erected by Peter McRae. Estimated cost is $35,000.

Contract for construction of frame hotel-building for Furst & Curley has been awarded to I. S. Harding, 227 10th avenue North, Seattle, for $85,000.

Skinner & Eddy will construct mill-construction machine-shop. Estimated cost is $70,000.

South San Francisco, Cal.—Carl Werner, Phelan Bdg., San Francisco, is preparing plans for brick and concrete building for city hall. Estimated cost is $50,000.

Spokane, Wash.—Contract for construction of three frame grain-elevators near The Dalles, Ore., and one at Kahlotus, Wash., has been awarded to the Grain Elevator Construction Co., Hyde Block, Spokane, for about $70,000 in all.

Stockton, Cal.—Carl Werner, Phelan Bdg., San Francisco,

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is preparing plans for reinforced concrete and terra cotta building for Stockton Masonic Temple Association. Estimated cost is $200,000.

M. C. Couchot, 110 Sutter street, San Francisco, is preparing plans for concrete bag-factory for Sperry Flour Co. Estimated cost is $80,000.

Vallejo, Cal.—Contract for construction of addition to Sperry Flour Mill at South Vallejo has been awarded to Dinwiddie Construction Co., Crocker Bdg., San Francisco, for $175,000.

Waterville, Wash.—Contract for construction of three grain-elevators, two of reinforced concrete and one of timber, for the Waterville Union Grain Co. has been awarded to Harrington & Peters, Oriental Bdg., Seattle, for $95,000.

BONDS

Coalinga, Cal.—Bond issue of $20,000 for completion of water system has been voted.

Mayfield, Cal—Bond issue of $6000 for construction of storm-drainage system has been voted.

Nogales, Ariz.—The only bid received for $175,000 worth of county highway bonds would have yielded only 92 cents on the dollar, so it was rejected.

Oakland, Cal.—Bond issue of $60,000 of Emeryville school district has been awarded to Central National Bank of Oakland for $60,346. These bonds bear 5% interest.

Orland, Cal.—Settlers on Capay ranch have voted bond issue of $15,000 for construction of a reinforced concrete school-building.

Portland, Ore.—Northwestern Electric Co. has sold bond issue of $1,500,000 bearing 6% interest to E. H. Rollins & Sons. Money will be used for construction of auxiliary steam-plant at Portland, for which C. C. Moore & Co., San Francisco, have the contract.

Sacramento, Cal.—State Board of Control has arranged to take $5,000,000 worth of State highway bonds. This leaves $5,000,000 worth of the $15,000,000 issue still unsold.

Santa Ana, Cal.—Bond issues of $38,500 for the construction of the Main Street bridge and $7700 for the construction of the Flower Street bridge have been voted. Pacific Electric Railway Co. will also contribute $7000 toward the cost of the Main Street bridge.

Sonoma, Cal.—Bond issue for purchase of water system failed to receive the necessary two-thirds majority.

Tracy, Cal.—Bond issue of $15,000 for extension of water and sewer systems has been voted.

MACHINERY AND SUPPLIES

Alameda, Cal.—Contract for furnishing two 500-kva. transformers has been awarded to General Electric Co. for $3800. Westinghouse Electric & Manufacturing Co. bid $3905 and Moloney Electric Co., $4860.

Berkeley, Cal.—Contract for furnishing a four-ton motor-truck to the city has been awarded to Moreland Motor Truck Co. for $4212.50.

Lodi, Cal.—Contract for furnishing 400 ft. of cast-iron water-pipe to city has been awarded to American Cast Iron Pipe Co., San Francisco.

Los Angeles, Cal.—Contract for furnishing ⅝-in. round reinforcing-steel to city has been awarded to Llewellyn Iron Works at $0.038944 per lb. or $6500 in all.

Contract for furnishing sand and gravel for military reservation at San Pedro has been awarded to Pacific Rock & Gravel Co. at $1.10 per ton for 250 tons of gravel and $0.90 per ton for 150 tons of sand.

Phoenix, Ariz.—Contract for furnishing corrugated culverts for county highway department has been awarded to Western Metal Manufacturing Co. at the following prices per foot: 18-in., $1.94; 24-in., $2.54; 30-in., $3.70; 36-in., $4.42; 48-in., $6.30.

Red Bluff, Cal.—Special tax of $12,000 for purchase of motor-driven fire-fighting equipment has been voted.

Reno, Nev.—Contract for furnishing a motor-truck to the fire department has been awarded to Steinheimer Bros. at $4900 for a Moreland truck.

Richmond, Cal.—Contract for furnishing a five-ton electric crane for use at municipal wharf has been awarded to Cyclops Iron Works, San Francisco, the only bidder, for $7500.

Contract for furnishing an electric motor-truck has been awarded to United Electric Vehicle Co., the only bidder, for $4383.16.

San Jose, Cal.—Contract for furnishing a 45-hp. caterpillar tractor to county has been awarded to Garden City Implement & Vehicle Co. for $4700, less 5% for cash and a further waiver of $150.

Santa Barbara, Cal.—Riverside Portland Cement Co. was low bidder at $1.93 per bbl., net f.o.b. Santa Barbara, for furnishing about 80,000 bbl. of cement for the Gibraltar dam.

Santa Cruz, Cal.—Board of Supervisors has purchased four motor-driven road sprinklers from the Fageol Motors Co., Oakland, at $4116 each.

MISCELLANEOUS

Marysville, Cal.—Contract for construction of concrete dam at Bullards Bar across Yuba river has been awarded to Oscar Ford, Riverside, on a cost-plus-percentage basis. About 5000 cu. yd. concrete will be required.

POSITION WANTED

POSITION WANTED as superintendent or foreman in charge railroad, hydro-electric, irrigation projects; general construction experience; all classes of concrete structures a specialty. Box 26, Western Engineering.

PROPOSALS

NOTICE TO CONTRACTORS

SEALED PROPOSALS for the construction and improvement of a channel by widening, deepening and straightening the channel of Newport Bay in the City of Newport Beach by dredging the same and for furnishing the labor and equipment therefor, all according to plans and specifications therefor and on file in the office of the City Clerk of said City, which plans and specifications are hereby referred to for a more particular and complete description of said work, will be received up to 7:30 P.M. of the 13th day of May, 1918 by the undersigned as City Clerk of the City of Newport Beach, at his office in the City Hall of said City.

All proposals shall be sealed and addressed to the City Clerk and endorsed on the outside "Proposals for dredging a channel in Newport Bay." Each proposal must be accompanied by a certified check payable to the City of Newport Beach for an amount not less than ten per cent of the total price bid. Bonds for the sum of $50,000.00 have been voted and sold for this work.

The City intends to let the contract for doing this work to the lowest, best and most responsible bidder and in determining the best and most responsible bidder shall not be governed wholly by the price of the work bid but shall have the right to take into consideration the knowledge and ability concerning the work of a bidder, also financial standing and past good faith of a bidder in doing other work either for the City of Newport Beach or any other person or corporation and also the right to take into consideration the equipment owned or to be used by a bidding contractor in doing the work. The City further and also reserves the right to reject any or all bids.

On the execution of the contract a bond in the sum of 50% of the contract price will be required to insure the faithful performance of the contract work. Also a bond to insure the payment of labor and material will also be required upon the execution of the contract to be in compliance with the provisions of Act 2895 of the Legislature of the State of California, approved March 27, 1897, as amended in 1911 and 1915. All bonds be with at least two and sufficient sureties subject to the approval of the Board of Trustees of the City of Newport Beach.

J. ROYAL LEMON,
City Clerk of the City of Newport Beach, California.

New and Used Contractors Machinery For Sale

1—½ yd. Ransome mixer.
1—¾ yd. Chicago mixer.
450 tons structural steel.
Triplex pumps, all sizes.
12—16—20 pound rail.
25—16 cu. ft. ore cars, 18" gauge.
Air compressors.
Air and water hose.
¾ yd. Smith mixer.
Concrete buggies and wheelbarrows.
4—2 yd. coal or sewer buckets.
Gasoline engines, all sizes.
1900 tons 56 pound rail.
250 tons 6" pipe.
5—Ingersoll-Rand jackhamers.
Hollow and solid drill steel.
2—150 HP. Atlas return tubular boilers, Hartford inspection certificate furnished guaranteeing condition.
2—5 HP. Fulton single friction drum hoists direct connected to G. E. variable speed motor, complete with controller resistance, etc.
1—8x10 Blake type jaw crusher, Demarest.
1—7x9 Blake type crusher, Joshua Hendy.
2—Sinking pumps, Smith-Vaile and Cameron make.

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